INSTRUCTION MANUAL

MODEL 146 MULTIFUNCTION GENERATOR

WAVETEK
SAN DIEGO

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

Serial No. _____

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Product Improvement Notice

Wavetek maintains a continuing program to make improvements to their instruments that will take advantage of the latest electronic developments in circuitry and components.

Due to the time required to document and print instruction manuals, it is not always possible to incorporate these changes in the manual.

Wavetek has manufactured your instrument, using metal film 1% tolerance resistors in place of 5% carbon resistors, wherever practical. This results in a substantial improvement in the overall performance of your instrument. Therefore, there may exist a discrepancy between the resistor used to manufacture your instrument and the resistor called out in the Parts List and Schematic Diagrams in this manual.

If field replacement of an affected resistor does become necessary, replacement may be made in accordance with the manual call outs. Wavetek, however, recommends replacement with the same type of resistor used in the manufacture of your instrument, whenever possible.

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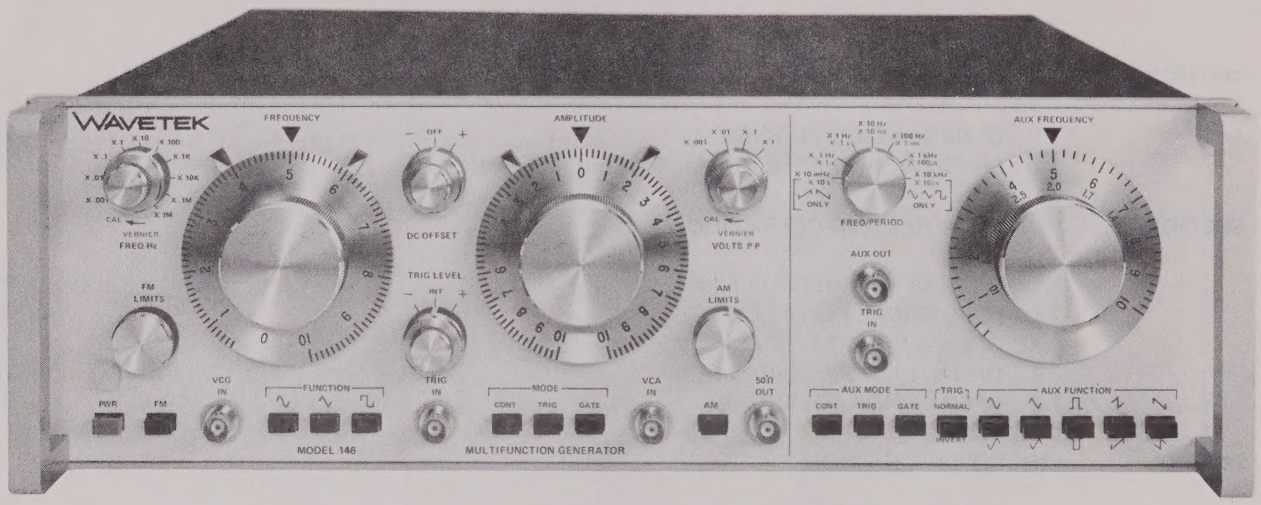

Figure i – Model 146 Multifunction Generator

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of this instrument. Wavetek's product improvement program ensures that the latest electronic developments are incorporated in all Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print instruction manuals, it is not always possible to incorporate the more recent changes in the released manual. In this case, data will be found on addendum change page(s) at the back of the manual.

We continue to rely on careful readers to help us improve future revisions of this instruction manual. If you should spot an error, inconsistency, or ambiguity, send your corrections and comments to:

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SECTION 1
INTRODUCTION

1.1 GENERAL CAPABILITIES

The Model 146 Multifunction Generator consists of two independent signal sources in one integrated unit. Each generator can be used as an individual signal source, or both can be used together. Functions and operating modes of both generators are push button selectable. The signal of the main generator can be frequency or amplitude modulated by any of the auxiliary generator waveforms. Analog control of output frequency and amplitude is provided by VCG (Voltage Controlled Generator) and VCA (Voltage Control of Amplitude) circuitry. Amplitude is variable from maximum through null to maximum at inverted phase. A caliper dial establishes upper and lower limits for frequency and amplitude modulation. Continuous, triggered and gated waveforms can be produced by the main generator through the range of 0.0005 Hz to 10 MHz. The auxiliary generator is capable of producing sine, square, triangle, and special sawtooth outputs. These waveforms can be internally applied to the main generator to obtain frequency modulation and frequency sweep up to 1000:1 ratio; amplitude modulation through 100% to suppressed carrier modulation; and triggered, gated and tone burst outputs. Operating range of the auxiliary generator is 0.004 Hz to 100 kHz. Both generators can be externally triggered. VCG and VCA connectors are available for external inputs to the main generator. Auxiliary and main generator output impedances are 600Ω and 50Ω, respectively.

1.2 PHYSICAL AND ELECTRICAL SPECIFICATIONS

MAIN GENERATOR

1.2.1 Versatility

Waveforms
Selectable sine ∿, square ⊓, and triangle ∧ and dc outputs. Symmetry of all outputs continuously adjustable from 1:19 to 19:1, with rear panel control. Varying triangle symmetry provides a positive slope sawtooth ◿, or negative slope sawtooth ◺ output. Separate sync with variable symmetry (see below). Waveform can be continuous, triggered, or gated.

Frequency Range
0.0005 Hz to 10 MHz in 10 decade ranges.

Ranges

X 0.001	0.0005 Hz to 0.01 Hz
X 0.01	0.005 Hz to 0.1 Hz
X 0.1	0.05 Hz to 1 Hz
X 1	0.1 Hz to 10 Hz
X 10	1 Hz to 100 Hz
X 100	10 Hz to 1 kHz
X 1K	100 Hz to 10 kHz
X 10K	1 kHz to 100 kHz
X 100K	10 kHz to 1 MHz
X 1M	100 kHz to 10 MHz

NOTE

When symmetry control is used, indicated frequency is divided by a factor of approximately 10.

Main Output
Sine, square, and triangle selectable. Maximum output 20 V p-p open circuit and 10 V p-p into 50Ω. Precision front dial controls the amplitude with high resolution and provides phase reversal of output. Output impedance is 50Ω. Short circuit current is 150 mA. Precision output range multiplier with four decade steps.

Sync Output
Amplitude greater than 4 V p-p into open circuit; 2 V p-p into 50Ω. Rise and fall times are less than 50 nanoseconds. Square waveform for symmetrical outputs; rectangular waveform for non-symmetrical outputs.

DC Offset
Can be controlled manually using the front panel control. Range of ±10 Vdc into open circuit (±5 Vdc into 50Ω load), peak output limited to ±15 Vdc into open circuit (±7.5 Vdc into 50Ω load). DC offset and output waveform are attenuated proportionately by the amplitude range multiplier.

Operating Modes
Continuous, triggered, and gated modes of the main and auxiliary generator are push button selectable. Triggering or gating of the main generator by the auxiliary generator is internal. The auxiliary generator may be triggered or gated by the main generator through external connections on the rear panel. Both generators provide for external triggering and gating.

1.2.2 Accuracy

Horizontal Precision

Frequency Accuracy of Symmetrical Waveforms
0.001 Hz to 1 MHz . . ±(1% of setting +1% of full scale)
1 MHz to 10 MHz . . ±(2% of setting +2% of full scale)
Applies for symmetrical waveforms.

Vernier
Electronic vernier controls provided for precision frequency and amplitude adjustment.

Time Symmetry
10 Hz to 100 kHz . . . . . ±0.5%
0.001 Hz to 500 kHz . . . . . ±0.1%

Vertical Precision

Amplitude Dial Accuracy
0.001 Hz to 10 kHz ±(2% of setting +2% of full scale). Accuracy stated is for X 1 amplitude multiplier. For X 0.1, X 0.01, X 0.001, add ±3% +1 mV.

Frequency Response (Sine Wave)
Amplitude change with frequency less than:
0.13 dB to 1 MHz
0.59 dB to 10 MHz

Stability
Short term . . . . . ±0.05% for 10 minutes
Long term . . . . . ±0.25% for 24 hours
Percentages apply to amplitude, frequency, and dc offset.

Amplitude Symmetry
All waveforms are symmetrical about ground within ±2% of maximum peak to peak amplitude.

1.2.3 Waveform Purity

Sine Wave Distortion
10 Hz to 100 kHz . . less than 0.5% (typically 0.25%)
0.001 Hz to 1 MHz . . . . . less than 1.0%
1 MHz to 10 MHz . . all harmonics at least 26 dB down

Triangle Linearity
Greater than 99% . . . . . 1 Hz to 100 kHz

Square Wave Rise and Fall Time (Terminated into 50Ω Load)
Less than 50 nanoseconds.

Total Aberrations
Less than 5%.

1.2.4 Analog Control Characteristics

Voltage Controlled Generator (VCG)
Up to 1000:1 frequency change with external voltage input. Required external signal for full control is 5 volts with input impedance of 5 kΩ. When the FM switch is depressed, the output of the auxiliary generator is connected to the VCG circuit and the FM LIMITS knob controls the amount of modulation.

VCG Control Range
Upper frequency is limited to maximum of selected range. Minimum and maximum frequencies are indicated by the caliper pointers and the center frequency is indicated by the frequency index when in internal sweep.

VCG Input Frequency
VCG Bandwidth . . . . . 100 kHz
VCG Slew Rate . . . . 2% of range per microsecond

VCG Linearity
10 Hz to 100 kHz . . . . . ±0.2%
0.001 Hz to 1 MHz . . . . . ±0.5%

Voltage Control of Amplitude (VCA)
Full amplitude control with an external voltage input of ±5 volts. The control is bipolar, that is, the amplitude can be controlled from maximum through null to range maximum at inverted phase. VCA input impedance is 10 kΩ. When the AM switch is depressed, the output of the auxiliary generator is connected to the VCA input. The AM LIMITS control adjusts the amount of AM modulation. Minimum and maximum amplitudes are indicated by the caliper pointers and the mean amplitude is indicated by the amplitude index.

VCA Response
Bandwidth 100 kHz, slew rate 2% of range per microsecond.

VCA Linearity
1% of full scale.

AUXILIARY GENERATOR

1.2.5 Versatility

Waveforms
Selectable sine ∿, square ⊓, triangle ∧, positive slope sawtooth ⟋, and negative slope sawtooth ⟍ outputs. Output level fixed 5 V p-p into open circuit. Approximately 2.5 V p-p into 600Ω (600Ω output impedance). Short circuit current is approximately 4 mA peak. Rear panel AUX SYNC OUT connector provides approximately 5 V sync signal.

Dynamic Frequency Range

0.004 Hz to 100 kHz (250 seconds per cycle to 10 μs per cycle) calibrated in frequency and time.

Operating Frequency Range

X 0.01 Hz . . .	0.004 Hz to 0.1 Hz (⟋ ⟍ only)
X 0.1 Hz	0.04 Hz to 1 Hz
X 1 Hz	0.4 Hz to 10 Hz
X 10 Hz	4 Hz to 100 Hz
X 100 Hz	40 Hz to 1 kHz
X 1 kHz	400 Hz to 10 kHz
X 10 kHz .	4 kHz to 100 kHz (∿ ⊓ ∿ only)

1.2.6 Environmental

Temperature

All specifications listed except for stability are for 25°C ±5°C. For operation from 0°C to 55°C, derate all specifications by a factor of 2.

1.2.7 Mechanical

Dimensions

17¼ inches wide, 5¼ inches high, 17 inches deep.

Weight

14 lbs net, 23 lbs shipping.

Power

105 V to 125 V or 200 V to 250 V, 50 Hz to 400 Hz. Less than 45 watts.

NOTES

All specifications apply for frequencies obtained when dial is between 1.0 and 10 on the Main and Auxiliary Generators. Main Generator output specifications apply at 10 V p-p into a 50Ω load.

It is possible to stop the generator from oscillating by applying a negative voltage when the dial is already set at a minimum frequency. Input up to 30 V will not permanently damage the instrument, however.

SECTION 2
INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to switches, connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packaging material should be retained in case reshipment is required.

A Wavetek Rack Adapter Kit will allow this unit to be mounted in a standard 19-inch equipment rack. No mechanical installation is required when the instrument is to be used as a portable bench unit.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, all Wavetek Model 146 instruments are shipped from the factory with the power transformer connected for operation on a normal 115-volt ac line supply, and a 1/2 ampere 115-volt slow-blow line fuse.

CAUTION

To convert to 230 volts, set the slide switch at the rear of the instrument to 230, and replace the fuse with a slow-blow fuse rated at 1/4 ampere at 230 volts. Connect the ac line cord to the mating connecter at the rear of the unit.

2.2.2 Signal Connections

Use 50Ω shielded cables equipped with female BNC connectors to distribute all RF signals when connecting this instrument to associated equipment.

2.3 OPERATING CONTROLS

The operating controls and electrical connections for the Model 146 are shown in Figures 2-1 and 2-2. Each of the following paragraph numbers corresponds to a number appearing in Figure 2-1, front panel, and Figure 2-2, rear panel.

FRONT PANEL CONTROLS

1. **FREQ Hz** — Selects one of ten decade ranges from X 0.001 to X 1M to establish the frequency multiplier for main generator frequency.

2. **Frequency VERNIER** — Allows precision control of the output frequency. A complete turn of this control is approximately equal to 1% of full scale on the FREQUENCY dial. When turned to the full clockwise position (CAL), settings on the main dial will be calibrated.

3. **FREQUENCY Dial (Main)** — Controls the frequency of the main generator. The setting on this dial multiplied by the frequency range setting (1) equals the output frequency of the generator. The frequency VERNIER (2) and the SYMMETRY ADJUST (39) (rear panel) also affect the generator frequency.

4. **FREQUENCY Index (Main)** — The lower point of the triangle above the FREQUENCY dial indicates the dial setting.

5. **Caliper Pointers (FM)** — Indicate the limits for frequency sweep or modulation on the FREQUENCY dial (3).

6. **DC OFFSET Control** — Controls the amount of dc or baseline offset above (+) or below (—) signal ground. The larger knob controls the polarity of dc offset and the smaller knob adjusts the baseline offset ±10 Vdc into an open circuit (±5 Vdc into 50Ω load), with peak output limited to ±15 Vdc into an open circuit (±7.5 Vdc into 50Ω load).

7. **AMPLITUDE Dial** — Allows calibrated control of amplitude for the main generator output. This control is bipolar; that is, as the dial is rotated from the full cw to full ccw, the output waveform will be

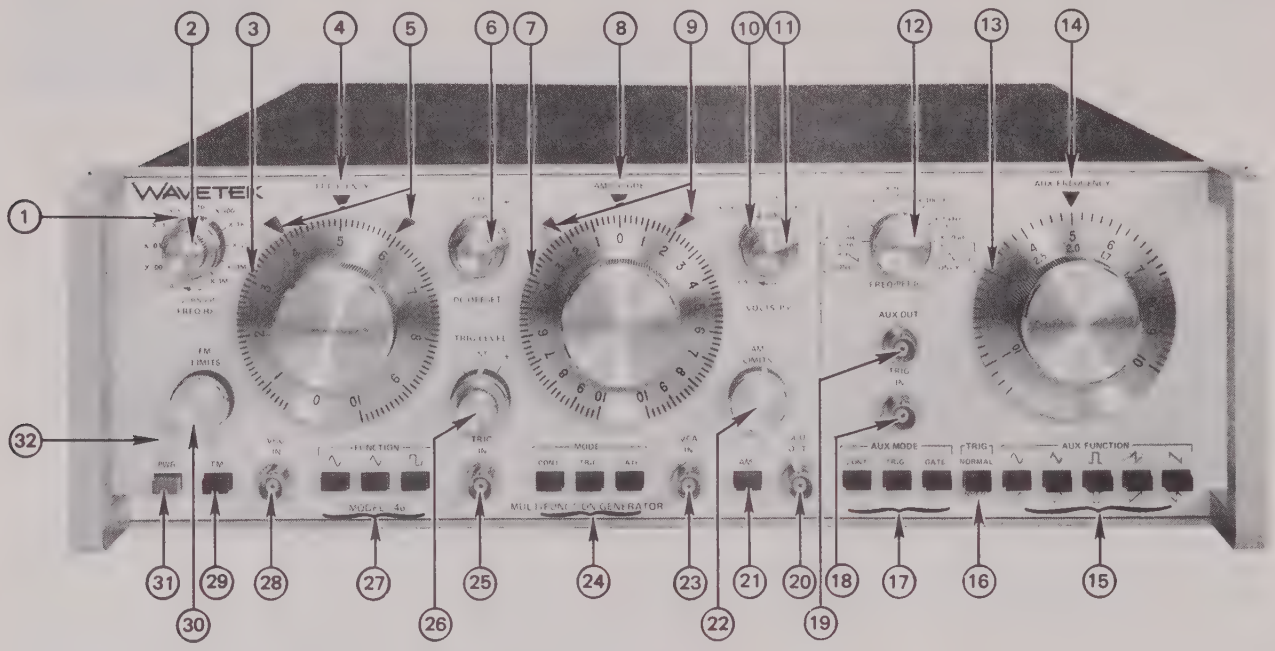


Figure 2-1. Operating Controls and Electrical Connections, Front Panel

phase shifted 180° as the dial passes through zero. This setting multiplied by the VOLTS P-P (10) setting and VERNIER (11) adjustment equals the main generator output amplitude.

8. **AMPLITUDE Index** — The lower point of the triangle above the AMPLITUDE dial indicates the dial setting.

9. **Caliper Pointers (AM)** — Indicate the limits for amplitude modulation on the AMPLITUDE dial (7).

10. **VOLTS P-P** — Attenuates the main generator output signal in four calibrated steps, X 1, X 0.1, X 0.01 and X 0.001.

11. **VOLTS P-P VERNIER** — Allows precision control over the output amplitude. A complete turn of this vernier is equivalent to approximately 5% of the AMPLITUDE dial (7) setting multiplied by the VOLTS P-P (10) selector setting. When in the full cw position (CAL), the setting on the AMPLITUDE dial (7) will be calibrated.

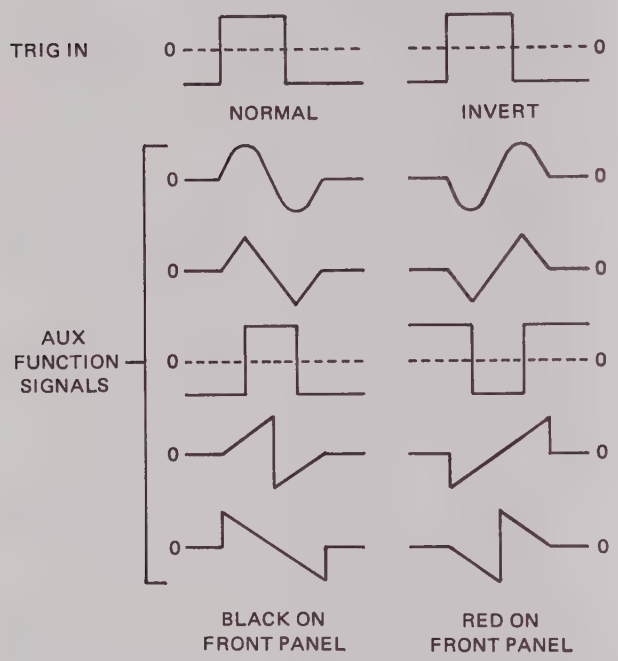
12. **FREQ/PERIOD** — Selects one of seven decade ranges from X 10 mHz to X 10 kHz (black numerals and letters) for auxiliary generator frequency. However, the X 10 mHz setting can only be used when the positive or negative slope sawtooth waveform ⟋ ⟍ is selected. The X 10 kHz setting can only be used when the sine ∿ , triangle ∧ , or square ⊓ (15) waveform is selected. The selected frequency range and black AUX FREQUENCY dial setting (13) determine the output frequency of the auxiliary generator. The dial and range multiplier are also calibrated in period for convenience. This calibration is indicated in red.

13. **AUX FREQUENCY Dial** — Controls the frequency of the auxiliary generator. The outer scale setting (black on this dial) multiplied by the selected frequency range (12) equal the output frequency of the auxiliary generator. The inner scale setting (red on this dial) multiplied by the selected period setting (12) gives the auxiliary generator period.

14. **AUX FREQUENCY Index** — The lower point of the triangle above the AUX FREQUENCY dial indicates the dial setting.

15. **AUX FUNCTION Selector** — Allows push button selection of the waveform to appear at the AUX OUT (19) connector. The waveforms are sine ∿ , triangle ∧ , square ⊓ , sawtooth ⟋ , and negative slope sawtooth ⟍ for normal functions. These waveforms appear in black above the push buttons. When the AUX MODE — TRIG or GATE push button is in the depressed position and the TRIG push button is in the depressed (INVERT) position, depressing one of the AUX FUNCTION push buttons will select the waveform appearing in red below the push button.

16. **TRIG** — Selects the state of the step source which controls the direction of integration when enabled by the TRIG IN signal (18). In the NORMAL (released) position, the auxiliary generator will start integrating positively and in the INVERT (depressed) position, it will start integrating negatively. This switch is only effective in the TRIG (17) or GATE (17) auxiliary mode. (Refer to the following illustration.)



17. **AUX MODE Selector**

CONT (Continuous Mode) — Allows continuous wave operation of the auxiliary generator at the selected frequency.

TRIG (Trigger Mode) — Allows the auxiliary generator to produce one complete cycle of output for each square wave pulse applied to the TRIG IN connector (18).

GATE (Gated Mode) — Operates the same as trigger mode, except that the auxiliary generator will continue to produce an output for the full time that the signal at the TRIG IN connector (18) exceeds the minimum gating level (approximately +2 volts). When the gating signal is removed, the generator will complete the last cycle.

18. **TRIG IN** — Provides a dc coupled input with 3 kΩ input impedance, when in the GATE mode (17). The minimum gating level (signal at TRIG IN connector) is +2 volts. When in the TRIG mode (17), the TRIG IN connector is ac coupled and requires a minimum input square wave of 4 volts peak to peak and 1 microsecond in width. Maximum external input level is 30 volts peak for both modes.

19. **AUX OUT** — Provides approximately 600Ω output impedance connection for all auxiliary generator output functions. The output amplitude is ±2.5 volts into an open circuit.

20. **50Ω OUT** — Provides 50Ω output impedance connection for all main generator output signals.

21. **AM** — When depressed, this push button enables amplitude modulation of the main generator signal by the waveform selected in the auxiliary generator. The frequency of the modulation envelope is determined by the auxiliary generator.

22. **AM LIMITS** — Opens the AM caliper pointers when turned in the cw direction and closes the pointers when turned in the ccw direction to set the amplitude modulation limits. The AM push button must be depressed to enable the caliper pointers to set the calibrated limits.

23. **VCA IN** — Provides connections for an external input signal up to ±5 volts for amplitude modulation of the main generator signal. Input impedance is 10 kΩ.

24. **MODE Selector**

CONT (Continuous Mode) — Provides continuous wave operation of the main generator at a fixed frequency.

TRIG (Trigger Mode) — Allows the main generator to produce one complete cycle of output for each pulse applied to the TRIG IN connector (25). Manual triggering can be accomplished by rotating the TRIG LEVEL control (26) from full ccw to full cw position with the TRIG LEVEL switch (26) in the positive (+) position. At higher generator frequencies, triggering with this manual control will be difficult. Use an external trigger.

GATE (Gated Mode) — Operates the same as trigger mode, except that the main generator will continue to produce an output for the full time that the signal at the TRIG IN connector (25) exceeds the minimum gating level (approximately +2 volts).

25. **TRIG IN** — Provides connection for an external trigger or gating signal to the main generator when the TRIG or GATE (24) push button is in the depressed position. The trigger signal should be at least ±3 volts dependent upon the position of the TRIG LEVEL switch (26). Maximum external input level is ±50 volts peak.

26. **TRIG LEVEL Selector and Control** — When the selector (larger knob) is set to the INT position, the main generator is triggered internally by the auxiliary generator. In the INT position, the TRIG LEVEL control adjusts the sensitivity of the trigger input circuitry, + (ccw) and — (cw). When an external trigger is used, the TRIG LEVEL selector must be set to the — or + position for selection of the respective negative or positive portion of the trigger signal. When the control is in the full cw position, approximately —15 volts is required for triggering. In the full ccw position, approximately +15 volts is required for triggering. At the midpoint, extremely low voltages will trigger the main generator.

27. **FUNCTION Selector** — Allows push button selection of the waveform to appear at the 50Ω OUT (20) connector. The waveforms are sine ∿ , triangle ∧ , and square ⊓ .

28. **VCG IN (Voltage Controlled Generator Input)** — Allows external control of frequency. With 0 voltage in, the generator output frequency is determined by the frequency range selected and the FREQUENCY dial setting. A positive VCG voltage will increase the frequency, and a negative voltage will decrease the frequency within the limitations described in 2.5.2. Input impedance is 5 kΩ.

29. **FM Switch** — Allows the main generator to be frequency modulated by the auxiliary generator when in the depressed position. The FM LIMITS (30) determines the amount of sweep or modulation.

30. **FM LIMITS** — Opens the FM caliper pointers when turned in the cw direction and closes the pointers when turned in the ccw direction to set the frequency sweep or modulation limits. The FM push button must be depressed to enable the caliper pointers to set the calibrated limits.

31. **PWR** — Applies power to the unit when push button is in the depressed position.

32. **Power Indicator** — Illuminates when the unit has been switched on.

REAR PANEL CONTROLS

33. **FUSE** — Protects the instrument from ac line transients as well as short circuits within the instrument. For 115 Vac operation, use a 1/2 ampere slow-blow fuse. For 230 Vac operation, use a 1/4 ampere slow-blow fuse.

34. **Power Receptacle** — Accepts a female power connector for applying 115 or 230 volts ac.

35. **115 — 230 Volt Switch** — Selects the power input voltage used. The instrument is normally shipped for 115 Vac and a 1/2 ampere fuse. To convert to 230 Vac, set slide switch to 230 and install a 1/4 ampere slow-blow fuse.

36. **AUX SYNC OUT** — Provides a synchronizing waveform at the same frequency as the auxiliary generator. The maximum output amplitude is 5 volts peak to peak into an open circuit.

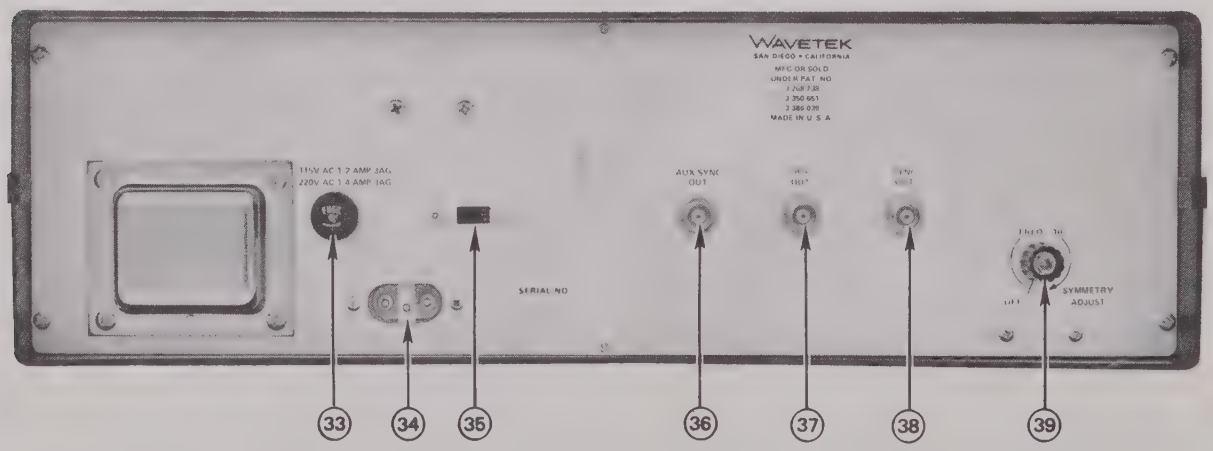


Figure 2-2. Operating Controls and Electrical Connections, Rear Panel

37. **GCV OUT** — Provides an analog voltage which is proportional to the output frequency of the main generator. This output is changed when the main generator FREQUENCY dial (3) is turned; a signal is applied to the VCG IN (28) connector; or the auxiliary generator is connected for frequency modulation of the main generator signal.

38. **SYNC OUT** — Provides a square or rectangular output at the same frequency as the main generator. The output amplitude is approximately 4 volts peak to peak into 50Ω impedance.

39. **SYMMETRY ADJUST** — Controls the time symmetry between the positive and negative portions of the output waveform. In the full ccw detented (OFF) position, the control is disabled and the output waveform has 1:1 symmetry (50% duty cycle). Rotating the control in a cw direction will release the calibrated detent and cause the frequency to divide by approximately 10. Continuing in a cw direction will vary the time symmetry from 1:19 through 19:1. This allows a minimum pulse width of approximately 50 nanoseconds with a repetition rate of 1 MHz.

2.4 INSTALLATION CHECKS

This paragraph outlines a quick checkout procedure to determine if the instrument is operating correctly. Field calibration and checkout instructions are given in Section 4 to determine compliance with electrical specifications. If electrical deficiencies exist, refer to the warranty on the back of the title page. Use an oscilloscope and counter-timer of the type stated in Table 4-1 when performing these installation checks.

1. Set front and rear panel switches and controls as follows (refer to Section 2.3 for location of controls):

SWITCH/CONTROL	POSITION/ROTATION
MAIN GENERATOR	
FREQ Hz	X 10
Frequency VERNIER	cw
FREQUENCY Dial	10
FM	out
FUNCTION	∿
DC OFFSET Switch	OFF
DC OFFSET Control	ccw
TRIG LEVEL Switch	INT
TRIG LEVEL Control	ccw
MODE	CONT
AMPLITUDE Dial	ccw at 10
VOLTS P-P	X 1
VOLTS P-P VERNIER	cw
AM	out
AUXILIARY GENERATOR	
FREQ/PERIOD	X 100 Hz/X 1 ms
FREQUENCY Dial	10
AUX MODE	CONT
TRIG	NORMAL (out)
AUX FUNCTION	∿

2. Depress PWR push button and check to assure indicator is illuminated.

3. Connect AUX OUT to oscilloscope. Check to assure waveform displayed is 5 V p-p open circuit (approximately 2.5 V p-p terminated into a 600Ω load) at 1 kHz.

4. Connect a BNC cable between auxiliary generator TRIG IN connector and main generator SYNC OUT (rear panel). Depress AUX MODE — TRIG push button. Check oscilloscope display to assure one cycle of selected waveform appears and is identical to waveform *above* selected function push button.

5. Depress TRIG (NORMAL/INVERT) push button. Check oscilloscope display to assure waveforms appear identical to waveform *below* selected function push button.

6. Depress AUX MODE — GATE push button. Check oscilloscope display to assure several cycles of selected waveform appear.

7. Depress AUX MODE — CONT push button.

8. Rotate AUX FREQUENCY generator dial cw to the 1 setting, while observing oscilloscope display. Sine wave frequency should change from 1 kHz to 100 Hz. Check range-to-range tracking accuracy with dial setting at 10.

NOTE

∿ , ∿ , and ⎍ functions will not operate on lowest range, X 10 mHz.

9. Depress AUX FUNCTION — ⟋ push button.

10. Check range-to-range tracking accuracy with dial setting at 10.

NOTE

⟋ and ⟍ functions will not operate on highest range, X 10 kHz.

11. Check remaining AUX FUNCTION selections for correct waveforms.

12. Connect AUX SYNC OUT connector (rear panel) to oscilloscope. Waveform display should be a 5 V p-p square wave for ∿ , ∿ , and ⎍ functions and 5 V p-p rectangular wave for ⟋ and ⟍ functions.

13. Set FREQ Hz switch to X 100 position.

14. Connect oscilloscope Trigger In Connector to instrument SYNC OUT connector (rear panel).

15. Connect 50Ω OUT connector to oscilloscope with 50 ohm terminator. Waveform should be 1 kHz sine wave at 10 V p-p. Rotate AMPLITUDE dial cw. Amplitude should decrease to zero when dial setting reaches 0 and should increase to 10 V p-p, 180° out-of-phase, at full cw setting.

16. Turn AMPLITUDE dial to 0; depress AUX FUNCTION ⎍ push button; and connect a BNC cable from AUX OUT connector to VCA IN connector. Check to assure amplitude of oscilloscope display is approximately 5 V p-p and symmetrical about ground.

17. Set DC OFFSET switch to – position. DC OFFSET control should vary waveform reference from 0 to at least –5 volts.

18. Set DC OFFSET switch to + position. DC OFFSET control should vary waveform reference from 0 to at least +5 volts.

19. Disconnect BNC cable from AUX OUT and VCA IN connector.

20. Set DC OFFSET switch to OFF position; depress AM push button; and turn AM LIMITS control until caliper pointers are on both 5s of AMPLITUDE dial. Check to assure amplitude of oscilloscope display is approximately 5 V p-p and symmetrical about ground.

21. Turn AMPLITUDE dial to either 10 (caliper pointers together); release AM switch; depress AUX MODE – CONT push button; depress MODE – TRIG push button; depress AUX FUNCTION – ∿ push button; set FREQ Hz to X 1K position; set FREQ/PERIOD switch to X 100 Hz position; and adjust Trigger Level Control until one cycle of selected waveform appears in oscilloscope display.

22. Depress MODE – GATE push button. Check oscilloscope display to assure multiple cycles of selected waveform appear when Trigger Level Control is rotated toward the cw extreme and disappear when the control is turned toward the ccw extreme.

23. Set TRIG LEVEL switch to negative (–) position. Connect BNC connector from AUX OUT connector to main generator TRIG IN connector. Check to assure multiple burst of cycles of selected waveform appears in oscilloscope display when the Trigger Level Control is rotated toward the cw extreme and disappears when the control is turned toward the ccw extreme.

24. Set TRIG LEVEL switch to positive (+) position. Check to assure multiple burst of cycles of selected waveform appears in oscilloscope display, when the Trigger Level Control is rotated toward the ccw extreme and that the generator free-runs when the control is turned toward the cw extreme.

25. Depress MODE – CONT push button; set TRIG LEVEL switch to INT position; turn Trigger Level Control fully ccw; and depress FUNCTION – ⎍ push button. Check to assure oscilloscope display is ⎍ waveform, 10 V p-p at 10 kHz.

26. Move VOLTS P-P switch to each position while checking oscilloscope display to assure correct attenuation at each position. Return VOLTS P-P switch to X 1 position.

27. Rotate VOLTS P-P VERNIER control to assure approximately 5% change of amplitude reading. Return control to CAL position.

28. Rotate FREQUENCY dial cw to the 1 setting, while observing oscilloscope display to assure square wave frequency changes from 10 kHz to 1 kHz. Check range-to-range tracking accuracy with dial setting at 10.

29. Rotate FREQ Hz VERNIER control to assure approximately 1% change in full scale frequency and return to CAL position.

30. Set FREQ Hz switch to X 10K position. Rotate SYMMETRY ADJUST control (rear panel) slightly cw until detent is disengaged. Check oscilloscope display to assure square waveform is unsymmetrical by a ratio of approximately 1:19 and the frequency is divided by approximately 10. Continue rotating the SYMMETRY ADJUST control through its entire range. Symmetry of the square waveform should vary from 1:19 through 1:1 to 19:1 at the full cw extreme.

31. Rotate SYMMETRY ADJUST control ccw to OFF position; set FREQUENCY dial to 0; set FREQ Hz to 1K position; depress AUX MODE – TRIG push button; depress AUX FUNCTION – ⎍ push button; depress TRIG push button to INVERT; and connect BNC cable between AUX OUT connector and VCG IN connector. Check to assure square waveform frequency in oscilloscope display is approximately 5 kHz.

32. Remove cable from AUX OUT and VCG IN connectors; turn FM LIMITS control cw; and depress FM push button. Check to assure square waveform frequency in oscilloscope display is approximately 10 kHz. Return FM push button to out position.

33. Connect oscilloscope to SYNC OUT connector. Check to assure square waveform in oscilloscope display is 4 V p-p (2 V p-p into 50 ohm load).

34. Connect oscilloscope to GCV OUT connector (rear panel). Rotate main generator FREQUENCY dial from fully cw to fully ccw. Check oscilloscope display to assure voltage level varies from 0 to +5 volts.

2.5 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks given in Paragraph 2.4 of this manual. It is recommended that a one-half hour warm-up period be allowed for the associated equipment to reach a stabilized operating temperature and for the Model 146 to attain stated accuracies.

2.5.1 Operation as a Function Generator

MAIN GENERATOR

1. Terminate 50Ω OUT connector with 50 ohm ±1% termination.

2. Select desired waveform and mode of operation by depressing respective FUNCTION and MODE push buttons.

3. Set desired output frequency by setting the FREQUENCY dial and FREQ Hz range multiplier to the respective positions.

4. Select desired amplitude of output by setting the AMPLITUDE dial and VOLTS P-P multiplier to the respective positions.

5. Select the polarity of dc offset desired using the DC OFFSET switch, and set the amount of offset using the VERNIER control. If an excessive amount of dc offset is used, waveform clipping may be observed. The sum of peak waveform voltage and dc offset cannot exceed the maximum rated output of the main generator. Maximum output is 15 V peak to peak or 7.5 V peak above and below 0 volts. Offset plus peak voltage cannot exceed 7.5 V. (See Figure 2-3.)

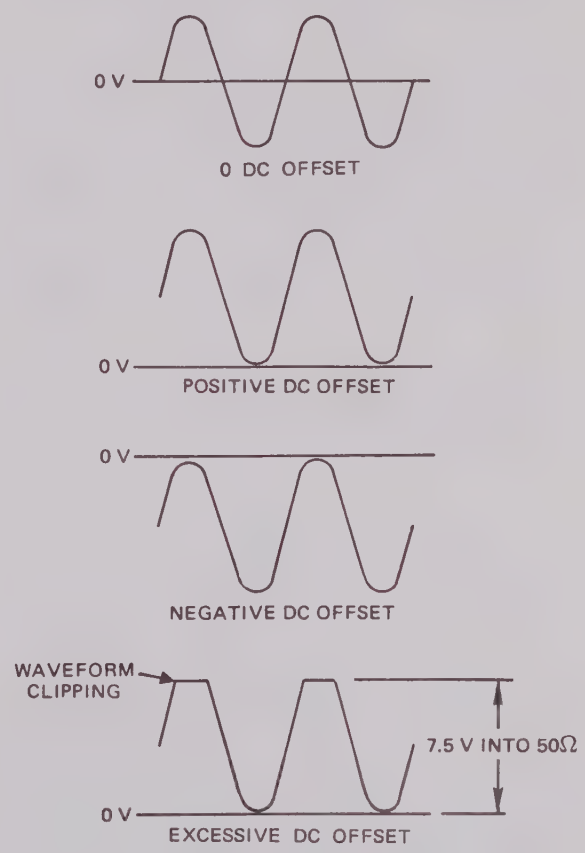


Figure 2-3. DC Offset Control

6. Set SYMMETRY ADJUST control for desired symmetry or dissymmetry. The symmetry control can be used to develop ramp waveforms with variable rise-fall ratios and pulse trains with variable duty cycle. By using the sine wave with dissymmetry, controllable sine distortion can be developed. Figure 2-4 shows the effect of this control on output waveforms.

AUXILIARY GENERATOR

1. Connect oscilloscope to AUX OUT connector (600 ohm output impedance).

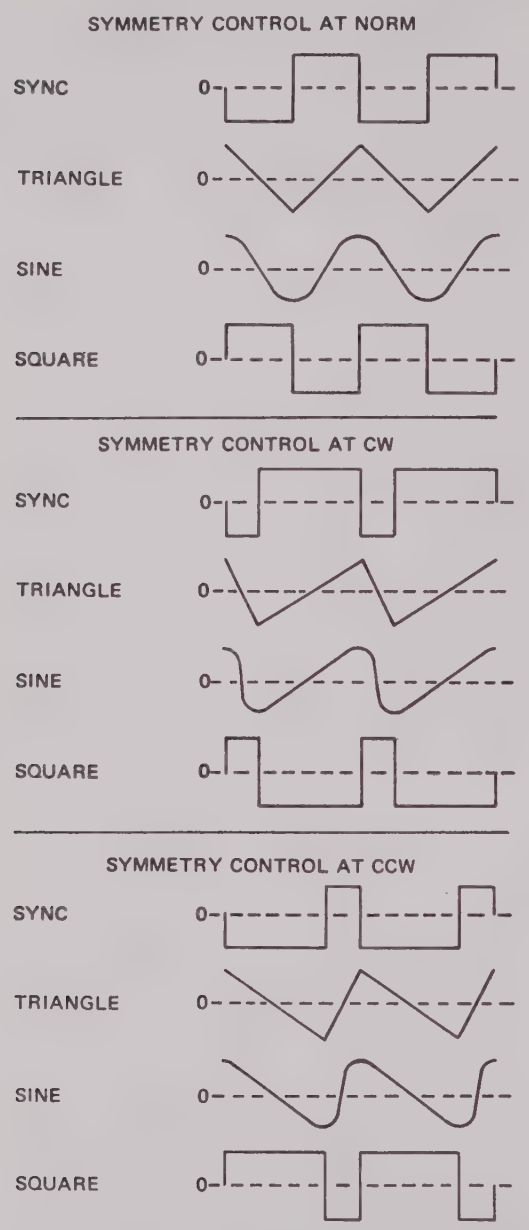


Figure 2-4. Waveform Phasing and Symmetry Control

2. Select desired waveform and mode of operation by depressing respective AUX FUNCTION and AUX MODE push buttons.

3. Set desired output frequency by setting FREQUENCY dial and FREQ/PERIOD range multiplier.

4. Output signal should be 5 volts p-p into an open circuit, or 2.5 volts p-p into 600 ohms.

2.5.2 Operation as a Frequency Modulated, Sweep or Voltage Controlled Generator

The frequency of the Model 146 may be modulated or changed in several ways as follows:

1. Modulated around a center frequency.

2. Swept from a low to a high frequency or a high to a low frequency.

3. Frequency Shift Keyed (FSK).

These and other types of frequency modulation may be performed internally or externally. The auxiliary generator provides the waveforms for the internal FM and the VCG IN connector allows an external signal to be used for FM.

Using the internal method of FM allows calibrating the limits of the modulation using the FM LIMITS control. This control spreads the caliper pointers to the desired calibrated limits.

The principle of operation is simple. An increasing voltage causes the frequency to increase and a decreasing voltage causes the frequency to decrease. Therefore, the type of frequency modulation depends only on the waveform used to FM. The following waveforms as selected from the auxiliary generator provide the indicated modulations:

∿ A sine wave input will cause the main generator to FM around the center frequency (f_c) by an amount of Δf (f_m). The f_c is the frequency as read off the main dial under the top index. The f_m is the value as read adjacent to the caliper pointers on the main dial if internal modulation is used. If external modulation is applied to the VCG IN connector, the amount of deviation, Δf, may be approximated using the voltage-to-frequency nomograph shown in Figure 2-5, or may be measured using a counter.

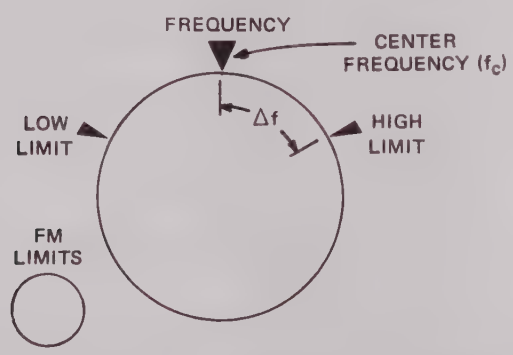
⎍ A square wave, or other dc shift, will cause Frequency Shift Keying (FSK). The frequency will instantaneously change to the two values as set by the pointers if internal modulation is used or as determined using the nomograph in Figure 2-5, if an external signal is applied to the VCG IN connector.

A positive sloped ramp will cause the main generator frequency to be swept from a low to a high value. If the internal auxiliary generator is used, these low and high limits may be set by rotating the FM LIMITS control in conjunction with the main FREQUENCY dial to achieve the desired *calibrated* end points of the sweep. The sweep limits are read off the main FREQUENCY dial adjacent to the pointers.

A negative sloped ramp will sweep the generator from a high to a low frequency in the same manner as described above.

INTERNAL FM

Using the internal method of frequency modulating is straightforward since the limits are calibrated. Note the following diagram.



The following is a step-by-step procedure for internal FM:

1. Set the main FREQUENCY dial in conjunction with the FM LIMITS control to the limits required by the application. Up to 1000:1 frequency deviation is allowed. The mechanical stops disallow incorrect settings.

2. Select the waveform which is to be modulated by depressing the appropriate FUNCTION push button on the main generator.

3. Depress MODE — CONT push button on the main generator.

4. Set the AMPLITUDE dial to the desired output level.

5. Set the AUX FREQUENCY dial to the desired rate of modulation.

6. Select the desired modulating waveform by depressing one of the AUX FUNCTION push buttons.

7. Select the desired AUX MODE.

8. Depress the FM push button on the main generator.

EXTERNAL FM

The VCG IN connector can be used to externally control the frequency of the main generator.

NOTE

When using an external voltage to FM, the FM LIMITS control has no affect.

The nomograph in Figure 2-5 may be used to determine the FM limits. If a positive voltage is applied to the VCG IN connector, the frequency will increase from the FREQUENCY dial setting. A negative voltage will cause the frequency to decrease. The VCG range of the Model 146 is 1000:1 on and FREQ Hz selector setting. With external voltage control the frequency can be driven to 0 in any range, but below 1/1000th of full scale, stability is insufficient for practical control.

The nomograph in Figure 2-5 shows the characteristics of the VCG circuit. Column A gives the FREQUENCY dial setting, column B, the VCG voltage and column C, the resultant frequency.

In Example 1, the FREQUENCY dial setting is 5 and the potential at the VCG IN connector is 0 volts. Extend a straight line from 5 (FREQUENCY dial setting) through 0 volts (VCG voltage). The result is an output frequency of 5 (multiplied by the FREQ Hz selector setting).

In Example 2, the FREQUENCY dial setting is 5 and a varying voltage of −1 volt to +1 volt is applied to the VCG IN connector. Extend a straight line from 5 (FREQUENCY dial setting) through −1 volt and another through +1 volt (VCG voltage). The result is an output frequency that will vary from 3 to 7 (multiplied by the FREQ Hz selector setting).

To obtain a maximum frequency change of 1000:1, such as sweeping from 10 kHz to 10 MHz, proceed as follows:

1. Connect a counter, or oscilloscope, to the 50Ω OUT connector.

2. Set the FREQ Hz selector to the X 1M position.

3. Turn the FREQUENCY dial cw to a frequency equal to 0.1 of full scale (100:1).

4. Rotate the frequency VERNIER control ccw to reduce the frequency another 10:1, thereby providing a fre-

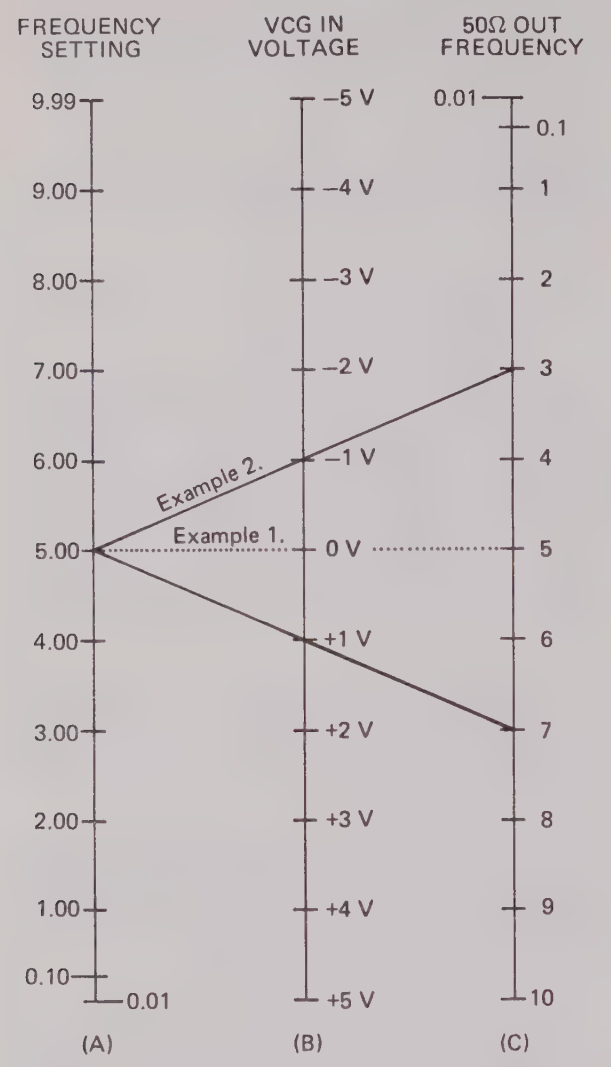


Figure 2-5. VCG Voltage-to-Frequency Nomograph

quency equal to 0.01 of full scale, 10 kHz (0.01 X 1M = 10 kHz).

5. Connect a 0 to +5 volt ramp signal to the VCG IN connector.

6. Observe that when the VCG signal increases to +5 volts, the output will have increased to a frequency equal to full scale (10 MHz), or 1000 times.

As another example, sweep down from 1 kHz to 1 Hz. The VCG input must be a 0 to −5 volt ramp signal with the FREQUENCY dial turned to 10 and the FREQ Hz selector set at X 100, or 1 kHz (the high frequency). At a −4.995 volt input, the generator will be at the minimum frequency for the X 100 range (0.01 X 100 = 1 Hz).

2.5.3 Operation as a Triggered Generator

2.5.3.1 MAIN GENERATOR TRIGGERED INTERNALLY

The main generator may be triggered internally or externally. The procedure for this mode of operation is:

1. Depress AUX MODE – CONT push button.

2. Depress desired AUX FUNCTION.

3. Set auxiliary generator to the desired triggering frequency. This frequency must be less than the main generator frequency.

4. Set main generator to the desired frequency.

5. Select desired output waveform by depressing the corresponding FUNCTION push button on the main generator.

6. Set TRIG LEVEL switch to INT position.

7. Depress MODE – TRIG push button.

8. Adjust TRIG LEVEL control so that the triggered output is present.

2.5.3.2 MAIN GENERATOR TRIGGERED EXTERNALLY

When triggering the main generator externally, an external source of ±1 volt minimum must be connected to the main generator TRIG IN connector. The procedure for this mode of operation is:

1. Connect an external trigger source (at least ±1 V) to the main generator TRIG IN connector.

2. Set external signal source to the desired triggering frequency. This frequency must be less than the main generator frequency.

CAUTION

Input level should not exceed ±50 volts peak.

3. Set main generator to desired frequency.

4. Select desired output waveform by depressing corresponding FUNCTION push button.

5. Set TRIG LEVEL switch to desired negative (–) or positive (+) position, as necessary.

6. Depress MODE — TRIG push button.

7. Adjust TRIG LEVEL control until triggering occurs.

2.5.3.3 AUXILIARY GENERATOR TRIGGERED OPERATION

When triggering the auxiliary generator, an external trigger source or the main generator may be used. The minimum voltage requirement from either trigger source is 4 volts peak. Minimum pulse width must be at least 1 microsecond, and the slew rate may not exceed 8 volts per microsecond. Inversion of the triggered output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the triggered cycle to be generated with a 180° phase reversal. The procedure for triggered operation is:

1. Connect main generator or external trigger signal source (square wave or pulse) to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source to desired triggering frequency with at least 4 V peak amplitude.

CAUTION

Input level should not exceed ±30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE — TRIG push button.

2.5.4 Operation as a Gated or Tone Burst Generator

2.5.4.1 MAIN GENERATOR GATED INTERNALLY

The main generator may be gated internally or externally. Gating internally on a square wave will not allow changing the number of cycles, due to the rapid rise time of the waveform. Using a sloping waveform in conjunction with the TRIG LEVEL control will allow selection of any number of discrete cycles to be generated. The procedure for this operation is as follows:

1. Depress AUX MODE — CONT push button.

2. Select desired triggering waveform (sine, triangle or ramp) by depressing the corresponding AUX FUNCTION push button.

3. Set auxiliary generator to desired frequency. This frequency must be lower than the frequency of the main generator.

4. Set main generator to desired frequency.

5. Select desired output waveform by depressing the corresponding FUNCTION push button.

6. Set TRIG LEVEL switch to INT position.

7. Depress MODE — GATE push button.

8. Adjust TRIG LEVEL control until the desired number of cycles in the burst is obtained.

2.5.4.2 MAIN GENERATOR GATED EXTERNALLY

When gating the main generator externally, an external signal source of ±1 volt minimum must be connected to the main generator. This signal cannot be one with a rapid rise time. Since the TRIG LEVEL control must be used to select voltage levels, a triangle, sine or ramp waveform should be used. The procedure for this mode of operation is:

1. Connect external signal source (sine, triangle or ramp) to main generator TRIG IN connector.

CAUTION

Input level should not exceed ±50 volts peak.

2. Set external signal source to desired frequency. This frequency must be lower than the frequency of the main generator.

3. Set main generator to desired frequency.

4. Select desired output waveform by depressing corresponding FUNCTION push button.

5. Set TRIG LEVEL switch to desired negative (—) or positive (+) position.

6. Depress MODE — GATE push button.

7. Adjust TRIG LEVEL control until the desired number of cycles in the burst is achieved.

2.5.4.3 AUXILIARY GENERATOR GATED OPERATION

When gating the auxiliary generator, an external gating source or the main generator may be used. The minimum requirement for either gating source is +2 volts peak. A sine,

triangle or ramp waveform should be used. Inversion of the gated output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the gated burst to be generated with a 180° phase reversal. The procedure for this operation is:

1. Connect main generator or external gating source to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source (sine, triangle or ramp) to desired frequency and amplitude (at least +2 volts peak).

CAUTION

Input level should not exceed 30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE – GATE push button.

6. Adjust main generator AMPLITUDE dial or external signal source level until the desired number of cycles in the burst is achieved.

2.5.5 Operation as a DC Voltage Source

The Model 146 Generator may be used as a variable dc voltage source not to exceed 100 mA of current. The AMPLITUDE dial is a calibrated control only when the instrument is connected to a 50 ohm load. The procedure is:

1. Depress the FUNCTION – ⊓ and MODE – TRIG push buttons.

2. Connect the 50Ω OUT connector to the device requiring the dc voltage source.

3. Turn the Trigger Level Control fully ccw.

4. Rotate FREQUENCY dial so that "10" is under the index (oscillation may occur at the bottom of the dial). Maximum level of ±15 V can be obtained into a 50Ω load.

5. The dc level may be adjusted using the AMPLITUDE dial and/or the DC OFFSET controls.

2.5.6 Operation as an Amplitude Modulated Generator

The Model 146 may be internally or externally amplitude modulated. If the auxiliary generator has the desired waveform describing the envelope and the desired frequency range, then the main generator should be amplitude modulated internally using the auxiliary generator.

If the auxiliary generator is not sufficient as the modulating source, an external signal may be applied to the VCA input connector.

In order to better understand the AM operation of the Model 146, please note the following:

"VCA" means Voltage Controlled Amplitude. Voltage controlled amplitude implies amplitude modulation. The VCA signal originates either internally from the auxiliary generator or externally via the VCA IN connector. This VCA signal is summed with the dc level selected by the p-p AMPLITUDE dial. By rotating the AMPLITUDE dial, a different dc offset is applied to the VCA signal. Now the VCA signal with its offset is multiplied times the carrier signal which originates from the main generator. The product of these two signals gives the AM output. Figure 2-6 shows the block diagram describing the algebraic process.

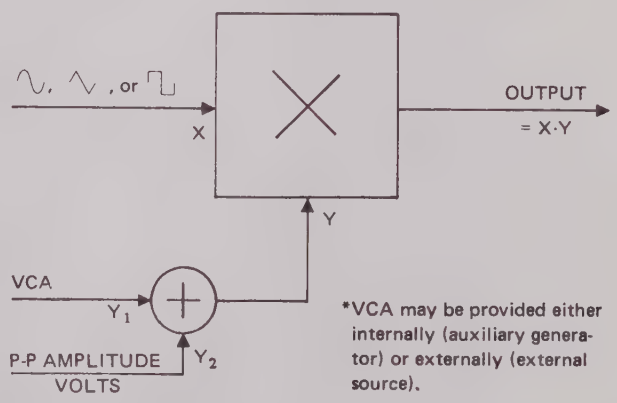


Figure 2-6. X-Y Multiplier Block Diagram

The VCA signal is Y_1, and the dc level from the p-p AMPLITUDE dial is Y_2. Hence, $Y = Y_1 + Y_2$ describes the envelope of the AM output. X is the carrier waveform; therefore, $X \cdot Y$ = AM output.

Figure 2-7 shows several amplitude modulated outputs corresponding to various VCA signals. Note that the percent of modulation may be determined by two factors: the amount of carrier amplitude provided by the AMPLITUDE dial as indicated by the fixed pointer and/or the amplitude of the

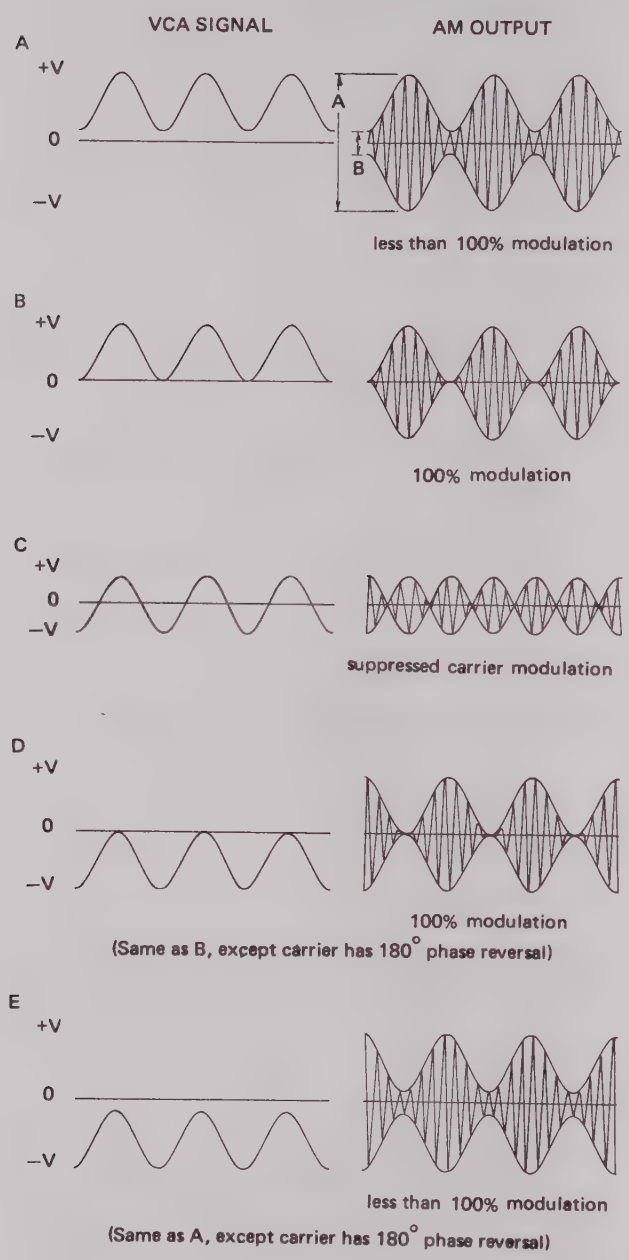


Figure 2-7. Amplitude Modulating Input and the Resultant Output

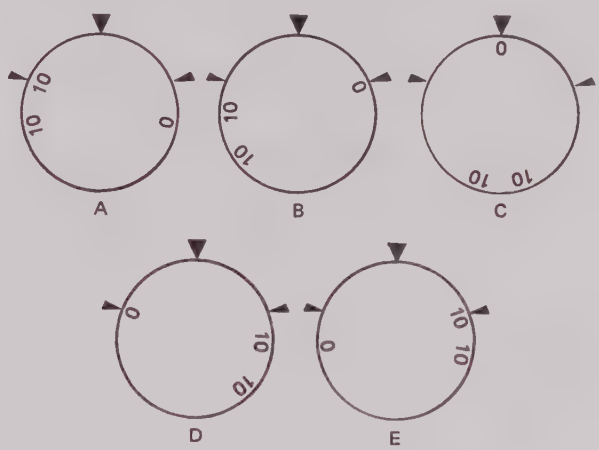
modulating waveform. When modulating internally, the percent of modulation is established using both the p-p AMPLITUDE dial and the AM LIMITS control. The p-p AMPLITUDE dial is providing carrier amplitude and the AM LIMITS control is varying the amplitude of the modulating waveform from the auxiliary generator. These pointers are calibrated, and the percent of modulation may be determined as follows (see Figure 2-7, Diagram A):

$$\frac{A - B}{A + B} \times 100 = \%\text{ of AM}$$

where A = the position of the left hand pointer

and B = the position of the right hand pointer

For example, the following AMPLITUDE dial and pointer positions provide the modulation shown in Figure 2-7.



When modulating with an external waveform, the AM LIMITS control does not control the gain of this signal and, therefore, the pointers may not be used to calibrate the amount of modulation. The gain must be adjusted externally. The p-p AMPLITUDE dial is the only control to set the amount of modulation.

Figure 2-8 provides a nomograph for several different externally applied modulating waveforms. It allows you to determine the peak limits of the amplitude modulated output. The following examples are provided for clarification:

Example 1 displays suppressed carrier modulation. The input must be symmetrical about ground of the Model 146. See Figure 2-7, Diagram C, for a display of the VCA input waveform and the resultant modulated output.

Example 2 shows 100% modulation. The envelope is 4 volts peak to peak. The input sine wave is 2 volts p-p with the negative peak equal to zero as referenced to signal ground of the Model 146. See Figure 2-7, Diagram B, for waveform display.

Example 3 illustrates the effect of using the AMPLITUDE dial together with a VCA input. The result is less than 100%

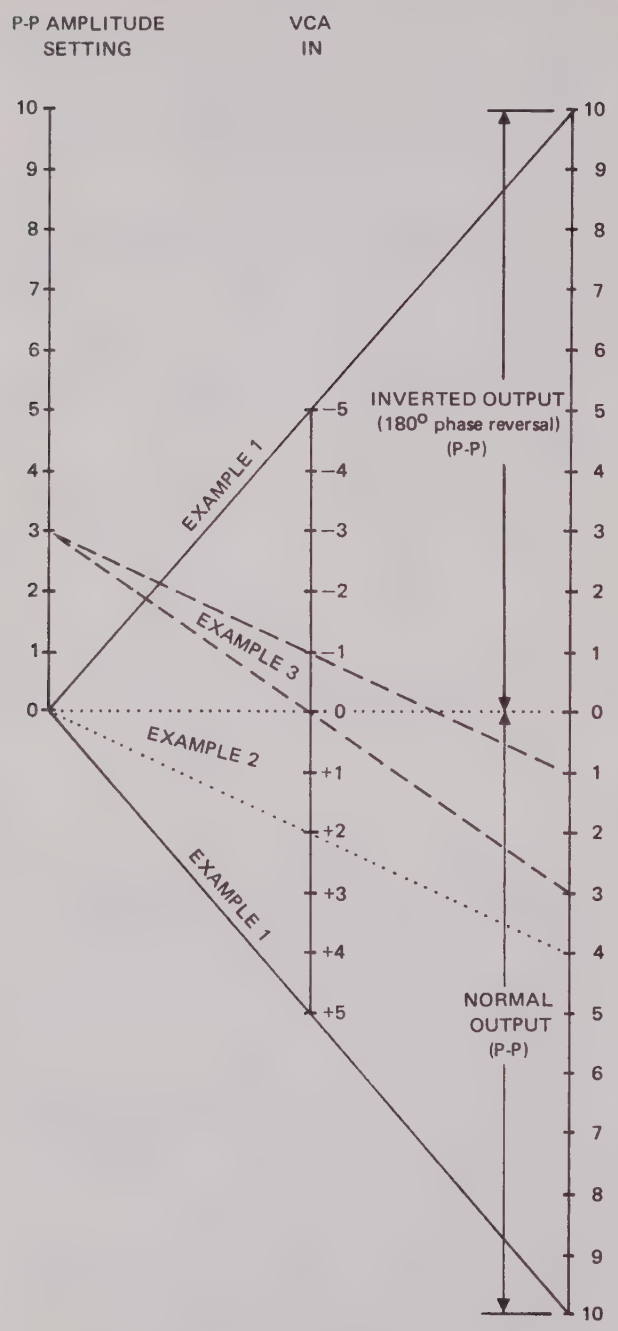


Figure 2-8. Amplitude Modulation Nomograph for an External Input

modulation, since the AMPLITUDE dial has offset the VCA input above signal ground. The effect is shown in Figure 2-7, Diagram A.

The following step-by-step procedures may be used to set up the generator for internal or external AM.

NOTE

The AM LIMITS control which spreads the caliper pointers around the AMPLITUDE dial is only used when modulating internally. Depressing the AM push button enables this control. An external input to the VCA is not affected by this control.

INTERNAL AM

1. Depress the desired FUNCTION push button to select the carrier waveform.
2. Depress the MODE – CONT push button. You may also operate in the TRIG or GATE mode for other applications.
3. Depress the AUX MODE – CONT push button.
4. Depress the desired AUX FUNCTION push button to select the modulating waveform.
5. Set the carrier frequency using the main generator.
6. Set the modulating frequency of the envelope using the auxiliary generator.
7. Depress AM push button.
8. Vary the AM LIMITS control and the p-p AMPLITUDE dial to set the desired amount of modulation.

EXTERNAL AM

1. Depress the desired FUNCTION push button on the main generator to select the carrier waveform.
2. Depress the MODE – CONT push button. You may also operate in the TRIG or GATE mode for other applications.
3. Set the carrier frequency using the main generator.
4. Be sure the AM push button is in the out position.
5. Connect the modulating waveform to the VCA input connector.
6. The percent of modulation may be varied using the AMPLITUDE dial on the main generator.

2.5.7 Operation as the Horizontal Driver of an Oscilloscope or X-Y Recorder

The Model 146 may be used to drive a display device to show many network response characteristics, such as frequency versus amplitude and frequency versus impedance. This is possible because the GCV OUT (No. 37, Paragraph 2.3) on the rear panel makes available an output voltage which is directly proportional to the instantaneous output frequency of the generator. As the main FREQUENCY dial is rotated, the GCV voltage changes proportionally with the change in frequency. This feature is used to calibrate the graticule of an oscilloscope or the X-axis of an X-Y recorder *directly in the frequency domain.* No time to frequency domain conversion is necessary.

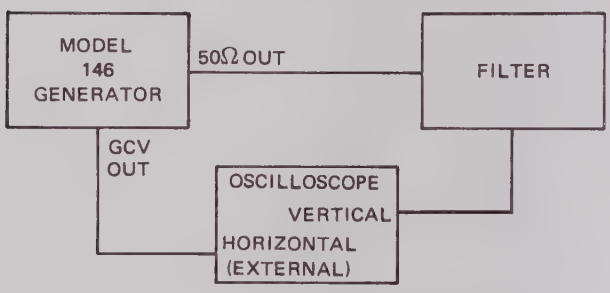


Figure 2-9. Test Setup for an Oscilloscope

Figure 2-9 shows a typical test setup in which GCV is used. The following step-by-step procedure demonstrates how to use GCV with an oscilloscope. In this example, assume that a filter is to be swept and a frequency versus amplitude plot is required.

1. Select the frequency range in which the sweep is to occur.

2. Rotate the FM LIMITS control and spread the calipers to the desired start and stop frequencies. (FM push button should be in the out position.)

3. Select the waveform to be used by depressing the desired FUNCTION push button on the main generator.

4. Depress MODE – CONT push button.

5. DC OFFSET should be OFF.

6. AM push button should be in out position.

7. Set AMPLITUDE dial and multiplier for the desired output.

8. Depress the AUX MODE – CONT and AUX FUNCTION – ∿ .

9. Set AUX FREQUENCY to desired sweep rate.

10. Connect the instruments as shown in Figure 2-9. Be sure scope is in the external horizontal mode.

11. Rotate the main FREQUENCY dial so that frequency which was adjacent to the left hand pointer (low frequency sweep limit) is now under the center index.

    Adjust the horizontal position of the scope so that the vertical component line is aligned with the left hand major vertical division.

12. Rotate the main FREQUENCY dial so that the frequency which was adjacent to the right hand pointer (high frequency sweep limit; see step 2) is now under the center index.

    Adjust the scope horizontal gain so that the vertical component is on the right hand major vertical division.

13. Repeat steps 11 and 12 to eliminate scope gain and position interaction.

14. Return main FREQUENCY dial to the position established in step 2.

15. Depress the FM push button. The scope will now show a frequency response of the filter. The sweep rate should be fast for a good envelope display.

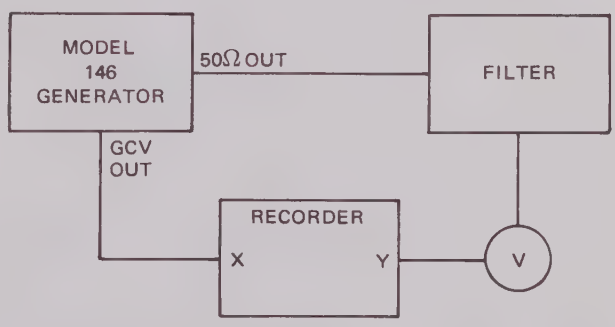


Figure 2-10. Test Setup for an X-Y Recorder

An X-Y recorder may also be driven with the GCV. See Figure 2-10. The procedure is similar to that for an oscilloscope, except that the auxiliary generator signal must be a triggered triangle (–∧–) waveform. The X-axis of the plotter may be calibrated in frequency by adjusting the horizontal gain in the same way as with the scope.

2.5.8 Operation as a Pulse Generator

The following pulse outputs are provided by the Model 146:

SINGLE PULSE DOUBLE PULSE PULSE TRAIN

The pulses may be either positive or negative by rotating the AMPLITUDE dial to either polarity. They may be unipolar or bipolar. The pulses may be rectangular, sinusoidal, triangular or sawtooth in shape.

The duty cycle may be continuously varied over a range of 1:19 to 19:1 by using a symmetry control. Pulse widths as narrow as 50 nanoseconds may be achieved.

Pulses may be generated in two ways:

1. By triggering a single cycle or gating two or more cycles of square waveform from the main generator, the repetition rate is controlled by the trigger source frequency and the pulse width is set by the main generator frequency. Refer to Paragraph 2.5.3 for trigger operation or Paragraph 2.5.4 for gated operation.

2. By using the symmetry control on the rear panel, the pulse width may be varied. The main generator FREQUENCY control selects the repetition rate. The symmetry control in effect is varying the duty cycle of the selected waveform over a range of 1:19 to 19:1. This control divides the frequency by approximately 10 when out of the detent position.

SECTION 3
CIRCUIT DESCRIPTION

3.1 GENERAL DESCRIPTION (Main Generator)

3.1.1 VCG Generator

A simplified block diagram of the VCG generator is shown in Figure 3-1. Triangle and square signals are generated simultaneously in the generator loop circuit. The triangle is then applied to a sine converter and amplified.

The frequency is controlled by the current from the VCG amplifier which, in turn, is controlled by the voltage from the VCG summing amplifier. Voltage from the VCG sum-

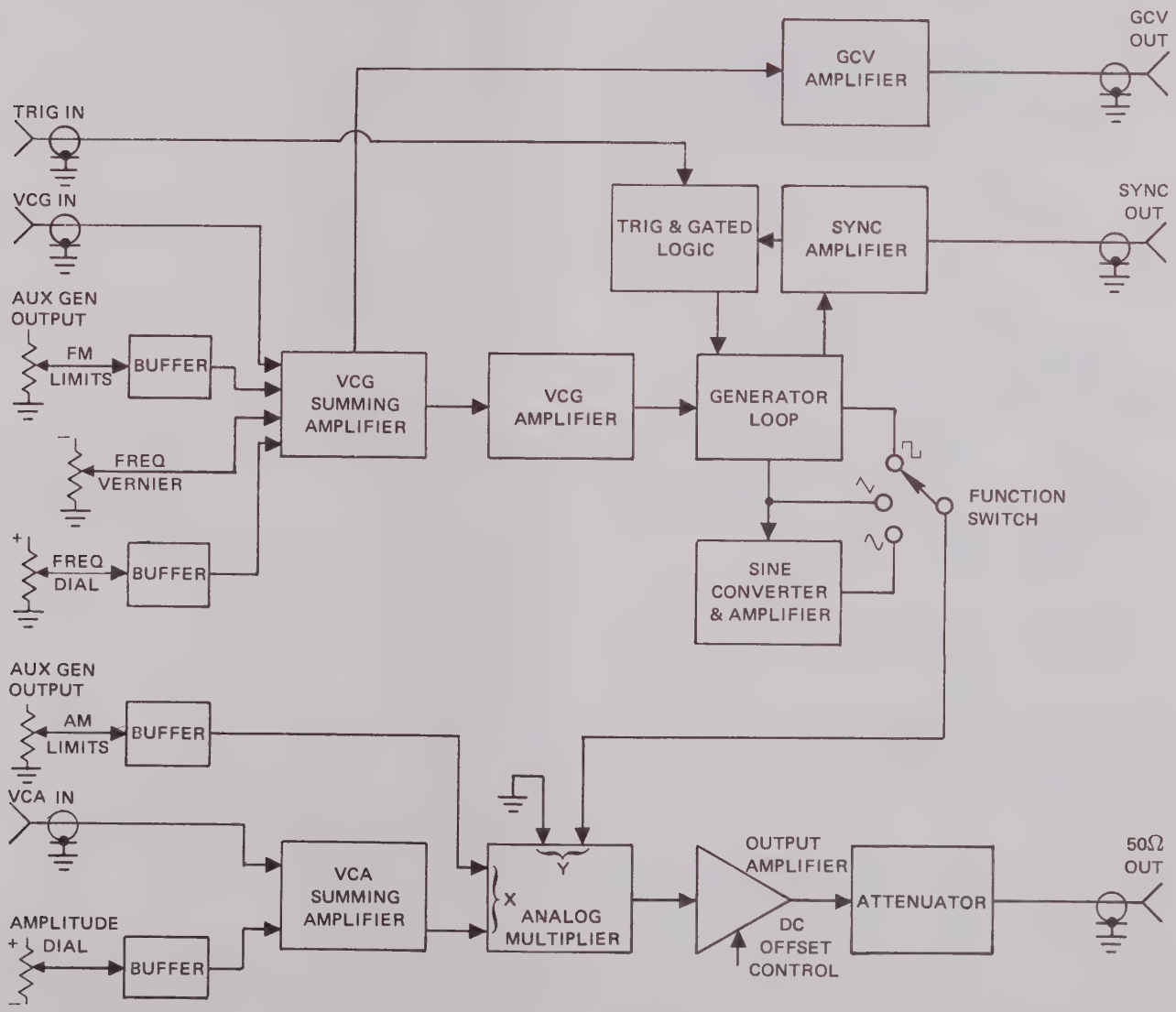


Figure 3-1. VCG Generator Simplified Block Diagram

ming amplifier is also fed into the GCV amplifier which gives a generator control voltage that is proportional to frequency.

One of the signals, square, triangle or sine, is fed into the X-Y multiplier and the amplitude is controlled by the VCA summing amplifier and AM limits buffer. The signal is then fed into the output amplifier. DC offset voltage can be varied positively, or negatively from the front panel dc offset control. The square wave from the triangle generator circuit is also fed into a sync amplifier to generate a sync output.

3.2 THEORY OF OPERATION

3.2.1 Generator Loop

When the voltage at point D is positive, the diodes CRA and CRD are reverse biased and CRB and CRC are forward biased. (See Figure 3-2.) Therefore, the current I+ is charging the capacitor **C** which causes the voltage at points **A** and **B** to rise. As soon as the voltage at point **B** reaches +1.25 V, the output of the hysteresis switch will switch negative and thus reverse the current flow. The current I− is drawn from capacitor **C**. Again, the hysteresis switch will switch positive when the voltage at **B** is below −1.25 V. Thus, triangle and square signals are generated simultaneously.

The output frequency depends on the size of the capacitor selected and the amount of currents, I+ and I−, charging the capacitor. Currents are controlled by the VCG amplifier which, in turn, is controlled by the voltage from the VCG summing amplifier.

3.2.2 VCG Amplifier and Current Sources

The voltage used to control the output frequency from the VCG amplifier is applied to point **A** of the VCG amplifier. (See Figure 3-3.) ICA and ICC are used to shift the control voltage ground reference to the power supply reference. ICB and ICD are the current source generators. The two current outputs are fed to the triangle generator.

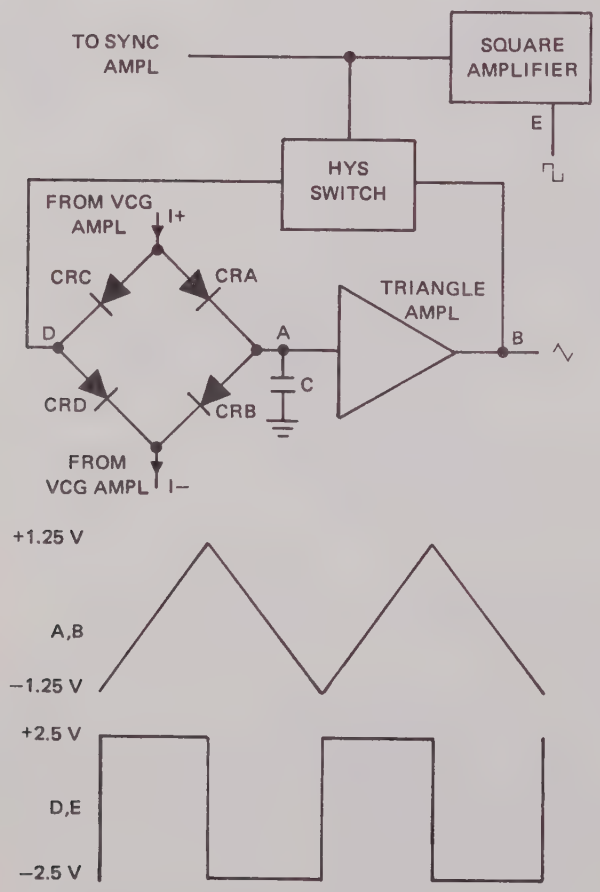


Figure 3-2. Generator Loop Block Diagram

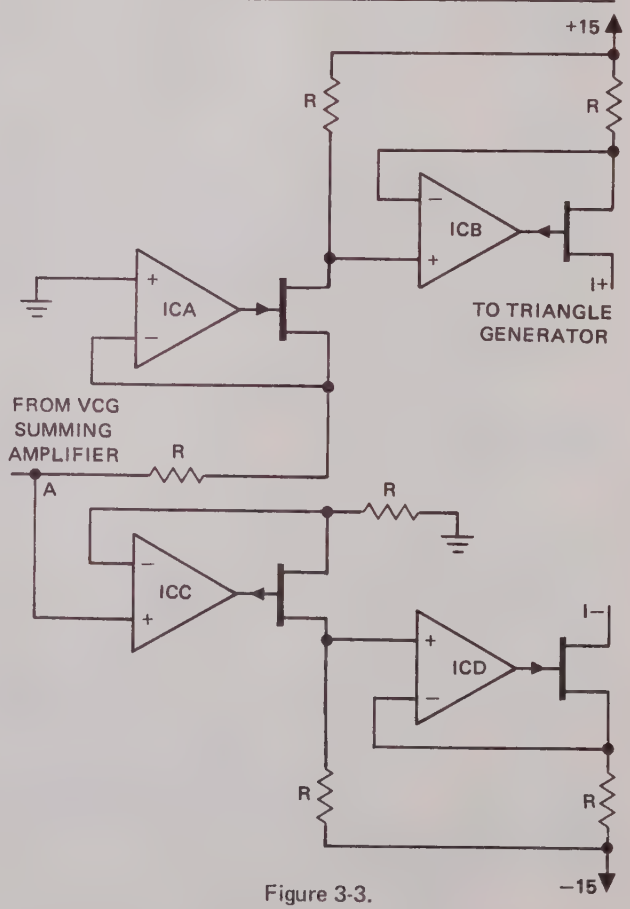


Figure 3-3.
Amplifier and Current Source Simplified Circuit

If the current of the negative current source is decreased by 19 times, the fall time of the triangle will be 19 times longer than the rise time of the triangle, resulting in an unsymmetrical waveform and a division of the frequency by a factor of 10. Symmetry of the output waveform can be continuously varied, while frequency is held constant. This can be obtained by gradually increasing the current from the negative current source and decreasing the current from the positive current source in such a way that the period for the triangle to complete one cycle remains constant. To accomplish this, the SYMMETRY ADJUST control on the rear panel must be utilized.

3.2.3 GCV Amplifier

The VCG amplifier output (0 to −5 volts) is fed to the generator control voltage (GCV) amplifier. This is a unity gain, inverting amplifier. From the GCV amplifier, the signal is applied to the GCV OUT connector. The GCV voltage (0 to +5 volts) is proportional to the output frequency.

3.2.4 Sine Converter and Amplifier

The sine wave is produced by feeding the triangle wave into a shaping network composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle voltage increases, diodes with current limiting resistors conduct successively, causing the slope of the output to be reduced.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform resembles a pure sine wave. Using a complimentary pair of diodes on each break point, the circuitry is completely symmetrical about ground. The sine wave, produced by shaping, is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

3.2.5 Capacitance Multiplier

Frequency ranging is achieved by selecting different capacitors. For frequency ranges at X 1 Hz or below, large capacitors are necessary and, therefore, impractical. Instead, a capacitance multiplier circuit is used, and ranging is achieved by changing the multiplication factor which is equivalent to the ranging resistors. The simplified circuit is shown in Figure 3-4.

Because of the nature of the feedback loop connection, A1 and A2, most of the current I+ and I− will be drawn by A2 through R1. Only a small percentage of current is charging and discharging capacitor C1. Therefore, the output frequency will appear much slower. The percentage of current

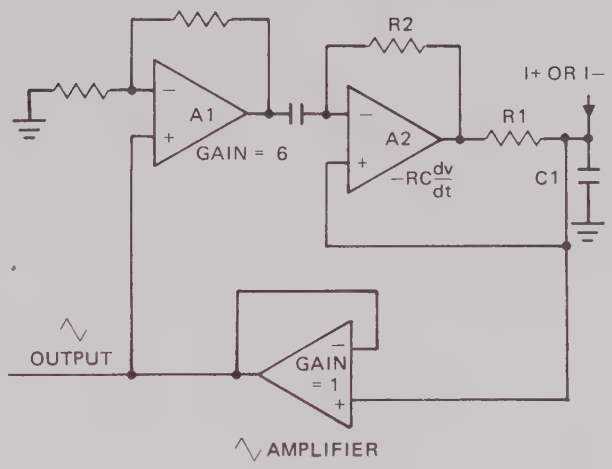


Figure 3-4. Capacitance Multiplier Simplified Circuit

drawn by A2 is precisely controlled by the loop gain and time constant of the capacitance multiplier circuit. Frequency ranging is achieved by changing R2.

3.2.6 X-Y Multiplier, Output Amplifier, and Attenuator

One of the signals is selected and fed into one of the Y inputs and a control voltage from the VCA summing amplifier and AM limits buffer are fed to the X inputs. (Refer to Figure 3-1.) The output from the X-Y multiplier is directly proportional to the product of the X and Y inputs.

The signal is then fed into the output amplifier. This is an inverting amplifier whose output is fed into a step attenuator and then to the output BNC connector (50Ω OUT).

3.2.7 Trigger Gated Modes

The triangle generator will oscillate continuously only if the voltage at **G** is negative which reverse biases CR48. (Refer to Figure 3-5.) This requires that the voltage at **E** or **F** be negative. If both voltages at **E** and **F** are positive, then so is the voltage at **G**. The current through CR48 will keep the voltage of **C** from falling below zero, because CR47 is clamped at zero. This stops the generator from oscillating.

The J-K flip-flop is used to control the timing, so that the triangle will always stop at the end of the cycle. If the trigger signal is reset between times t_1 and t_3, the triangle will stop at time t_3, as shown in the timing diagram.

If the signal at **B** is differentiated before it is applied to the J-K flip-flop, only one cycle of the triangle signal will be generated for each trigger input.

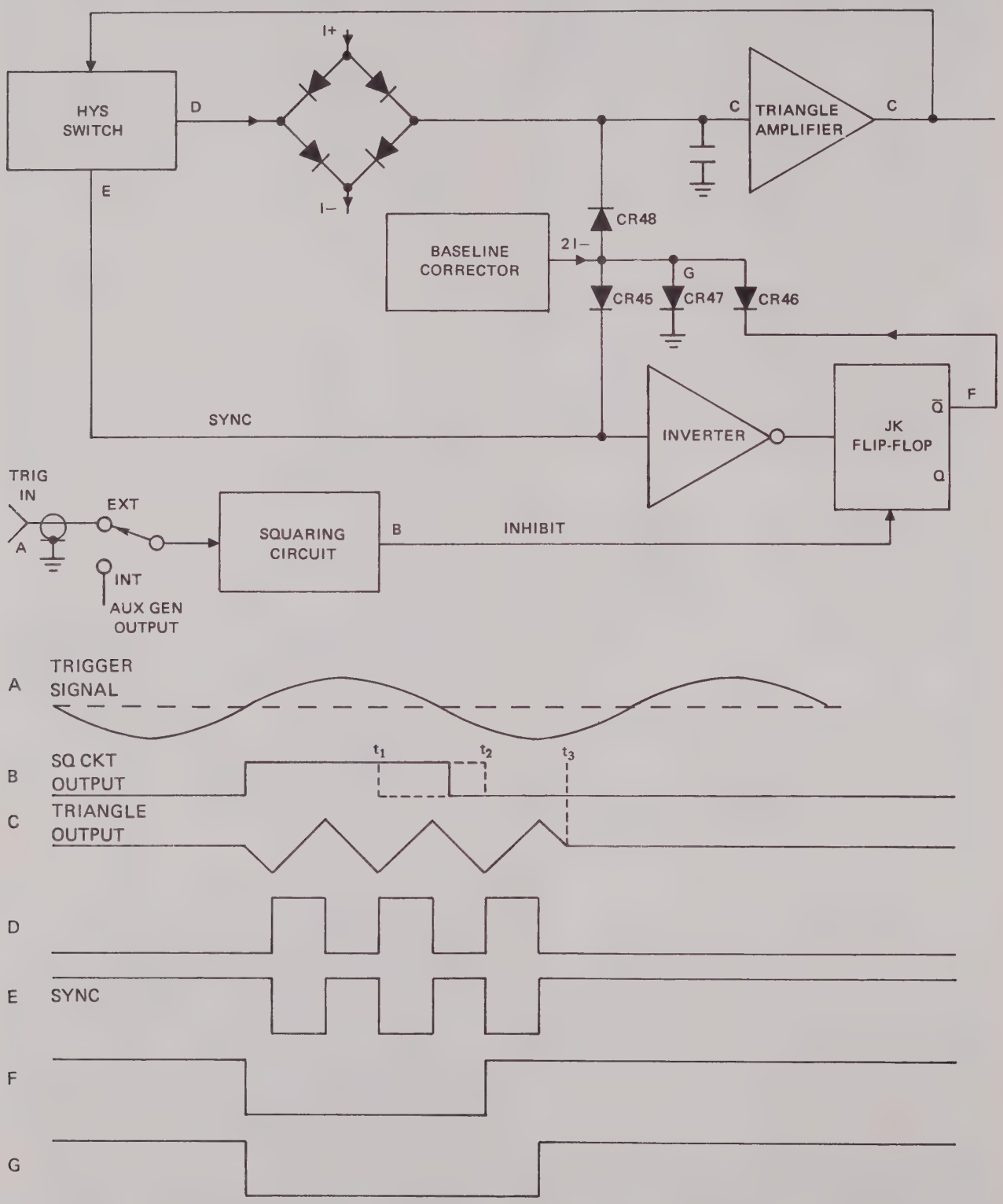


Figure 3-5. Trigger Gated Block and Timing Diagrams

3.3 GENERAL DESCRIPTION (Auxiliary Generator)

A simplified block diagram of the auxiliary generator is shown in Figure 3-6. The dial pot picks off a −dc voltage proportional to frequency from 0 to −15 V. This voltage is fed to a potentiometric buffer to guard against modification of this voltage by load current.

This buffered generator control voltage is fed through a switched resistive voltage divider to the reference or + input of the operational amplifier used as the integrator. This voltage is the exact common mode voltage seen by the integrator. For time symmetrical waveforms (i.e., ∿ ∿ ⎍) this common mode voltage is just half of the output of the dial buffer. For the down ramp ⤡ it is nearly all of the dial buffer output and for the up ramp ⤢ it is only a small part.

The amplifier and clamp is a circuit which multiplexes alternately between 0 Vdc and the output of the dial buffer on command from the logic generated at the hysteresis switch. The combination of this step function signal and the dc common mode voltage fed to the integrator causes a bipolar voltage to be developed across the integrating resistor which is appropriate for the waveform that is being generated.

A square wave is applied to the input of the integrator. The output of the integrator, a triangle wave, is fed into a hysteresis switch. The hysteresis switch functions like a Schmitt trigger with the limit points set at the waveform extremes, firing when the triangle wave reaches +1.25 volts and −1.25 volts. The firing set the hysteresis switch which reverses the square wave fed into the integrator, causing the triangle wave to reverse direction. The result is simultaneous generation of a square wave and

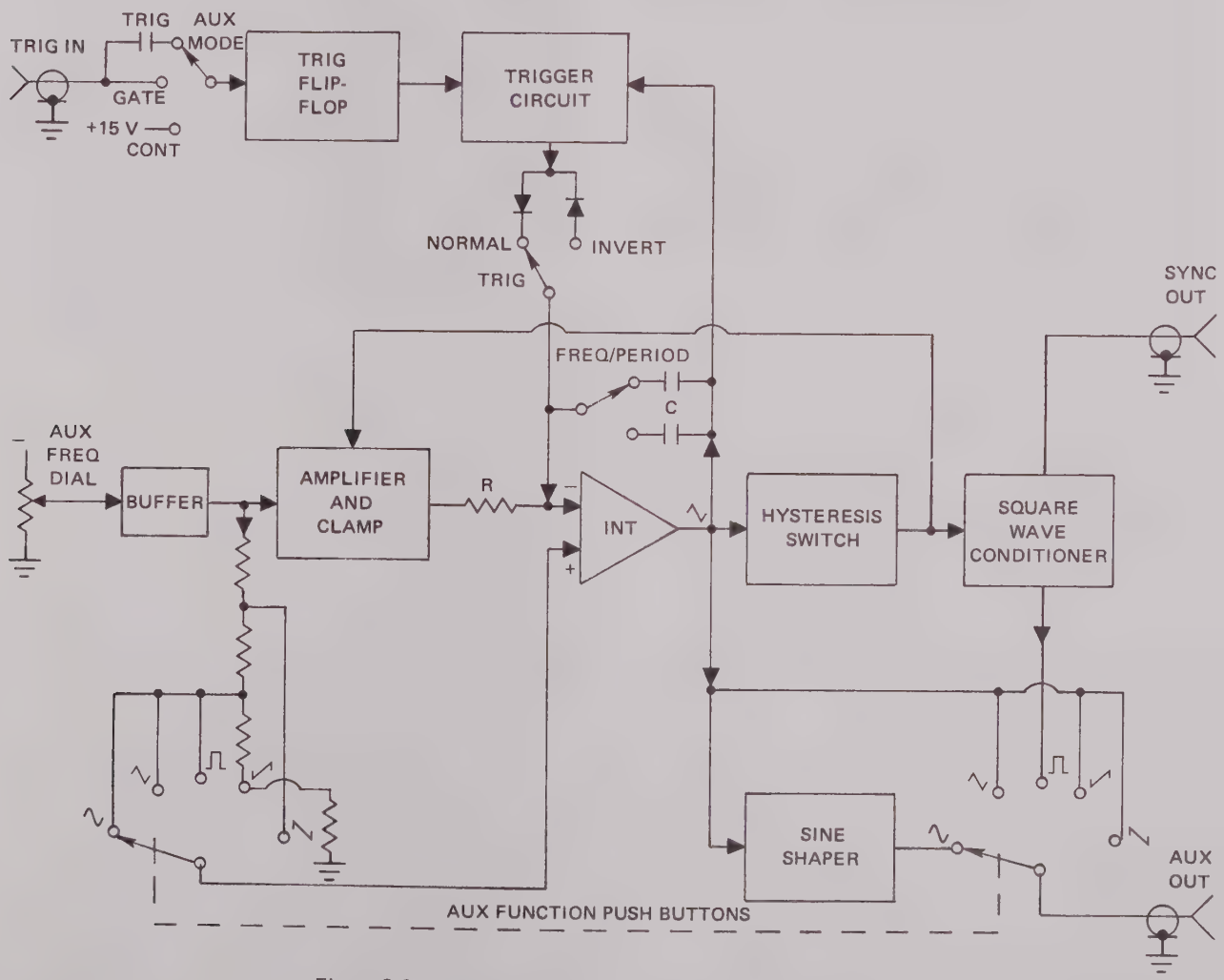


Figure 3-6. Auxiliary Generator Simplified Block Diagram

triangle wave of the same frequency with the positive half cycle of the square wave coincident with the negative slope of the triangle wave.

The frequency of oscillation is determined by the magnitude of capacitor C selected with the FREQ/PERIOD switch and by the amplitude of the square wave fed into the integrating resistor R. Setting the potentiometer for maximum voltage, and thus maximum integrating current, produces an output at maximum frequency. Frequency is directly proportional to the amplitude appearing on the arm of the frequency dial potentiometer.

The sine wave is produced by shaping the triangle wave. The triangle wave is fed into a shaping network composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle wave voltage increases, diodes with current limiting resistors conduct, successively, causing the slope of the output to be less.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform is an almost pure sine wave. The circuitry is completely symmetrical about ground, using a complimentary pair of diodes on each break point. The sine wave produced by shaping is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

Selection of a sync or an inverting sync signal for the trigger flip-flop will determine at which phase, positive or negative, the ground clamping feedback loop will be enabled. (See Figure 3-6.) If the TRIG push button is in the NORMAL (out) position, the integrator output will be integrating positively when clamped to ground at the zero crossing. At this point, the amplitude and clamp will be positive with respect to the integrator input common mode voltage. When a gating pulse is applied to the TRIG IN connector, the integrator will start integrating negatively, since the step source is positive. When the TRIG push button is in the INVERT (depressed) position, the integrator output will be integrating positively when clamped to ground at the zero crossing. At this point, amplifier and clamp will be negative with respect to the integrator input common mode voltage. When a gating pulse is applied to the TRIG IN connector, the integrator will start integrating negatively, since the amplifier and clamp are negative. (See illustration on page 2-3 under number 16.)

The generator trigger circuit is disconnected in the continuous-frequency operation just described. When a trigger or gated operation is selected, this circuit places a shunt path between the integrator input and output. Therefore, there is no output at the BNC until an external trigger/gate signal is applied to the trigger input connector. A trigger input enables the generator for one complete cycle of the selected waveform; then, the generator is disabled until another trigger arrives. A gate input allows the generator to function for the duration of the gate.

SECTION 4
CALIBRATION AND MAINTENANCE

4.1 INTRODUCTION

This section provides instructions for testing, calibrating, trouble-shooting and repairing the Model 146 instrument. The instructions are concise and written for the experienced electronics technician or field engineer. Wavetek maintains a factory-repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. A list of sales/service offices for repair of the instrument is also available on pages iii and iv of this manual. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to facilitate the turnaround time. The main board test point and adjustment locations are shown on the board itself and all points are illustrated in the data package.

4.2 RECOMMENDED TEST EQUIPMENT

Table 4-1 contains a list of recommended test equipment. Any test equipment having equivalent accuracies may be substituted for those listed.

Table 4-1. TEST EQUIPMENT

Type	Required Characteristics
Oscilloscope	To 250 MHz
Oscilloscope	To 30 MHz
Plug-in	Dual Channel
Plug-in	Peak mV measuring capability
Distortion Analyzer	To 600 kHz
Spectrum Analyzer Display	To 50 MHz
IF Section	
RF Section	
Differential Voltmeter	Microvolt dc measurement
Counter-Timer	To 10 MHz 0.1% of reading accuracy

4.3 ACCESS INSTRUCTION

Removal of the top and bottom dust covers affords quick access to all of the components within the unit.

4.3.1 Removing the Dust Cover

1. Unplug the power cord.
2. Unscrew three screws on top cover.
3. Remove top cover.
4. Follow same procedure for bottom cover removal.

4.4 CALIBRATION INSTRUCTIONS

The following paragraphs provide complete sequential calibration procedures for the Model 146 instrument.

NOTE

The entire calibration procedure must be read first to determine initial control settings and test equipment connections required before attempting recalibration. The steps of this procedure should be performed in the sequence given and the parts within each step should also be performed in the same sequence given. See fold-out on page 4-19 for test point location.

4.4.1 Preliminary Procedures

Allow the unit to warm up for at least 30 minutes. Start the calibration by setting the switches and controls as follows:

FREQ Hz Switch	X 100
Frequency VERNIER	CAL
FREQUENCY Dial	10
DC OFFSET Switch	OFF
DC OFFSET Control	fully ccw
TRIG LEVEL Control	fully ccw
TRIG LEVEL Switch	INT
AMPLITUDE Dial	fully ccw
VOLTS P-P Switch	X 1
Amplitude VERNIER	CAL

FREQ/PERIOD Switch	X 10 Hz
AUX FREQUENCY Dial	10
AUX FUNCTION Selector	∿
AUX MODE Selector	CONT
AM Switch	released (off)
MODE Selector	TRIG
FUNCTION Selector	∿
FM Switch	released (off)
SYMMETRY ADJUST	(rear panel) OFF
PWR	depressed (on)

4.1 Power Supply Regulation

1. Connect ac power to the instrument and connect the voltmeter leads to TP1 (common) and TP2 (+15 V) on the power supply board.

2. Adjust R21 for a reading of +15 Vdc ±20 mV.

3. Check the voltage at TP3 for −15 Vdc ±50 mV, at TP4 for +28 Vdc ±400 mV, at TP5 for −28 Vdc ±400 mV, and at TP6 for +5 Vdc ±100 mV.

4.2 Auxiliary Triangle Amplitude

1. Connect the oscilloscope with a BNC cable to AUX OUT (unloaded). Use a peak mV measuring capability plug-in module in oscilloscope.

2. Adjust the triangle amplitude to ±2.5 V ±50 mV using R42 (+) and R58 (−). Card 1 Block 4

4.3 Auxiliary Square Wave Amplitude

1. Depress AUX FUNCTION ⎍ and adjust the square wave amplitude to ±2.5 V ±5 mV using R98 (+) and R110 (−). Card 1 Block 2

4.4 Auxiliary Frequency Dial Alignment

1. Set AUX FREQUENCY dial to 10.

2. Set FREQ/PERIOD switch to X 100 and adjust R10 to obtain 1 kHz ±1 Hz. Card 1 Block 3

3. Adjust R10 for optimum frequency on X 100, X 10, X 1, and X 0.1 of FREQ/PERIOD switch.

4. Set FREQ/PERIOD switch to X 1K and adjust C10 for 10 kHz ±10 Hz. Card 1 Block 4

5. Set FREQ/PERIOD switch to X 10K and adjust C12 for 100 kHz ±100 Hz. Card 1 Block 5

6. Set FREQ/PERIOD switch to X 10, AUX FUNCTION selector to ⟋, and adjust R26 to obtain 100 Hz ±0.1 Hz. Card 1 Block 6

7. Set AUX FUNCTION selector to ⟍ and adjust R30 to obtain 100 Hz ±0.1 Hz. Card 1 Block 7

8. Set AUX FREQUENCY dial to 1 and adjust R1 to obtain 10 Hz ±0.1 Hz. Card 1 Block 8

9. Set AUX FUNCTION selector to ⟋ and adjust R35 to obtain 10 Hz ±0.1 Hz. Card 1 Block 9

10. Repeat steps 6 through 10 until all frequencies are correct.

4.5 Auxiliary Sine Distortion, Amplitude, and Balance

1. Set AUX FUNCTION selector to ∿, FREQ/PERIOD to X 100, and FREQUENCY dial to 10.

2. Adjust R61 to balance output.

3. Adjust R67 to obtain 5 V p-p ±10 mV output. Card 1 Block 10

4. Connect the test equipment as shown in Figure 4-1. Model 146 connects to the AUX OUT.

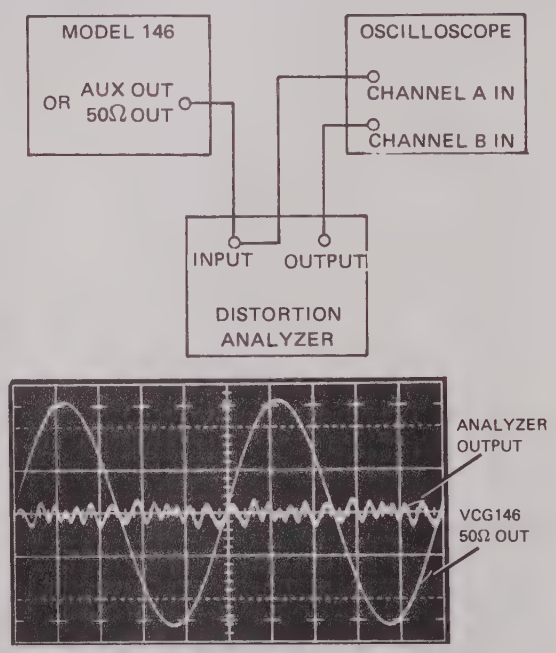


Figure 4-1. Distortion Analysis Test Set Up

5. Adjust R28, R53 and R55 for minimum sine distortion.

6. Repeat steps 2 and 3 to obtain ±2.5 V ±5 mV. Card 4 Block 11

4.6 Triangle Amplitude Adjustment

1. Set MODE selector to CONT and AUX MODE selector to TRIG.

2. Connect a X 1 oscilloscope probe to TP7 (∿). Use a peak mV measuring capability plug-in module in oscilloscope.

3. Adjust the triangle amplitude to ±1.25 V ±5 mV, using R96 (+) and R99 (–). Card 4 Block 12

4.7 Frequency and Time Symmetry Calibration

1. Set FREQ Hz to X 10K, FREQUENCY dial to 10, and frequency VERNIER to CAL.

2. Adjust R5 to obtain 100 kHz ±100 Hz. Card 4 Block 13

3. Turn FREQUENCY dial to 1/100 of full scale and verify accuracy with oscilloscope. While opening and shorting the VCG IN, adjust R35 for minimum frequency shift.

4. Adjust time symmetry within 0.1% with R18. Card 4 Block 14

5. Set FREQUENCY dial to 1 and adjust R34 to obtain 10 kHz ±10 Hz. Card 4 Block 15

   Check for 1000:1 FM operation. If necessary, readjust R34 to maintain 1000:1 operation and requirements in first paragraph of Step 5.

6. Repeat steps 1 and 4, as necessary, for accurate frequency at 10 and 1 on the dial.

7. Set FREQ Hz to X 1M, FREQUENCY dial to 10, and adjust C31 to obtain an output frequency of 10 MHz ±10 kHz. Check frequency accuracy from 1 to 10 on the dial and readjust C31 to split the error, if necessary. Card 4 Block 16

8. Set FREQ Hz to X 100K, FREQUENCY dial to 10, frequency VERNIER to CAL and adjust C42 to obtain 1 MHz ±1 kHz at the output. Check frequency accuracy from 1 to 10 on the FREQUENCY dial and readjust C42 to split the error, if necessary. Card 4 Block 17

9. Set FREQUENCY dial to 10 and frequency VERNIER to CAL position.

10. Set FREQ Hz to X 1K and adjust R6 to obtain 10 kHz ±10 Hz. Card 4 Block 18

11. Set FREQ Hz to X 100 and adjust R7 to obtain 1000 Hz ±1 Hz. Card 4 Block 19

12. Set FREQ Hz to X 10 and adjust R8 to obtain 100 Hz ±0.1 Hz. Card 4 Block 20

13. Set FREQ Hz to X 1 and adjust R23 to obtain 10 Hz ±0.01 Hz. Card 4 Block 21

14. Adjust R23 for optimum frequency on X 1, X 0.1, X0.01, X0.001 of FREQ Hz selector.

15. Set FREQUENCY dial fully ccw, frequency VERNIER to CAL and FREQ Hz to X 1.

16. Adjust R73 for 0.1% time symmetry. Card 4 Block 22

4.8 Sine Distortion

1. Set FREQ Hz to X 100, frequency VERNIER to CAL, FUNCTION selector to ∿ and FREQUENCY dial to 10.

2. Connect X 1 oscilloscope probe to TP8 (∿).

3. Adjust R141 so that the dc offset of the sine amplifier is zero.

4. Connect the test equipment as shown in Figure 4-1. Model 146 connects to the 50Ω OUT.

5. Adjust R134, R135 and R136 for minimum sine wave distortion.

6. Set FREQ Hz to X 1K and readjust R134, R135 and R136 for optimum sine distortion.

7. Alternately perform steps 5 and 6 until the least amount of sine wave distortion is obtained on both ranges (typically 0.14%). Card 4 Block 23

8. Connect oscilloscope probe to TP8 (∿).

9. Adjust R159 for a 2.5 V p-p ±5 mV signal output from the sine amplifier. Card 4 Block 24

10. Readjust R141 so that the dc offset of the sine amplifier is 0 V ±5 mV. Card 4 Block 25

4.9 X-Y Multiplier Adjustment

1. Set FREQ Hz to X 100, FREQUENCY dial to 10 and FUNCTION selector to ∿ .

2. Turn AMPLITUDE dial to null waveform at 50Ω OUT (loaded with 50Ω).

3. Adjust R231 for 0 V ±10 mV. Card 4 Block 26

4. Set amplitude to 1 V p-p and decrease amplitude until the straight sides of the triangle wave become parabolic.

NOTE

Avoid decreasing the amplitude so far that the waveform folds over into a null.

5. Adjust R201 for an unwarped triangle.

NOTE

It is not necessary to perform step 5 with great care at the initial higher amplitudes.

6. Repeat steps 4 and 5 until the triangle is down to about 50 mV p-p.

NOTE

It is normal for the 50 mV triangle to be fuzzy and somewhat distorted, but the potentiometer should be set for optimum linearity. Increase oscilloscope sensitivity as necessary to observe the signal.

7. Readjust R231 for 0 V ±10 mV.

8. Set AMPLITUDE dial to 0 and adjust R9 on switch board to null waveform at 50Ω OUT.

9. Turn AMPLITUDE dial to either 10 and adjust triangle from 50Ω OUT (loaded with 50Ω) for ±5 V peak ±25 mV with R228 (amplitude) and R205 (balance). Card 4 Block 27

10. Turn AMPLITUDE dial to other 10 and check to assure waveform is within ±5 V peak ±50 mV. If not, reset R228 and R205 for optimum amplitude and balance at both 10s. Card 4 Block 28

11. Set FUNCTION selector to ∿ and AMPLITUDE dial to either 10.

12. Connect the test equipment as shown in Figure 4-1.

13. Adjust R195 for minimum sine distortion at both 10s of the AMPLITUDE dial.

14. Set FUNCTION selector to ∿ and repeat steps 10 through 13 for optimum amplitude and balance and minimum sine distortion.

4.10 Square Wave Amplitude Adjustment

1. Set FUNCTION selector to ⊓ and set AMPLITUDE dial to either 10.

2. Adjust the square wave amplitude from 50Ω OUT (loaded with 50Ω) for ±5 V ±25 mV using R167 and R169. Card 4 Block 29

3. Turn dial to other 10 and check that waveform is within ±5 V ±50 mV. If not, reset R167 and R169 for optimum amplitude at both 10s.
Card 4 Block 30

4.11 Sine Wave Amplitude and Balance Adjustment

1. Set FUNCTION selector to ∿ and AMPLITUDE dial to either 10.

2. Adjust the sine wave amplitude from 50Ω OUT (loaded with 50Ω) for ±5 V ±25 mV using R159 (amplitude) and R141 (balance).
Card 4 Block 31

3. Turn AMPLITUDE dial to other 10 and check to assure the waveform is within ±5 V ±50 mV. If not, reset R159 and R141 for optimum amplitude at both 10s. Card 4 Block 32

4.12 AM LIMITS Adjustment

1. Set FUNCTION selector to ⊓ , MODE selector to TRIG, AM LIMITS control fully cw, AUX MODE selector to CONT, AUX FUNCTION to ⊓ , and depress AM push button.

2. Adjust R5 on switch board for square wave amplitude at 50Ω OUT (loaded with 50Ω) for 10 V p-p ±50 mV.
Card 4 Block 33

4.13 Trigger Base Line Adjustment

1. Set AUX MODE selector to TRIG and FUNCTION selector to ∿ ; release AM push button and turn AM LIMITS control fully cw.

2. Adjust R80 for 0 V ±5 mV at 50Ω OUT (loaded with 50Ω). Card 4 Block 34

3. Turn AMPLITUDE dial to other 10 and split the error from 0 V by readjusting R80.

4. Set FREQUENCY dial to 1/100 of full scale and adjust R257 to set base line to 0 V ± error accrued in step 3.

5. Check to assure base line remains within ±100 mV at all FREQUENCY dial settings from full scale to 1/100 of full scale.

4.14 GCV OUT Adjustment

1. Set MODE selector to CONT and FREQUENCY dial to 10.

2. Adjust R52 to obtain +5 Vdc ±10 mV at GCV OUT connector. Card 1 Block 35

4.15 High Frequency Response Adjustment

1. Set FREQ Hz to X 0.1M, FREQUENCY dial to 10 and FUNCTION selector to ⊓ .

2. Adjust C85 for optimum square wave, without peaking, from 5 V p-p to 10 V p-p output amplitude.
   Card 1 Block 36

3. Set FUNCTION selector to ∿ , FREQUENCY dial to 10 and FREQ Hz to X 1M.

4. Adjust C26 to obtain 10 V p-p output amplitude.

4.16 CORRECTIVE MAINTENANCE

This portion of the manual presents a systematic approach to trouble-shooting. It is composed of two parts. Part one (see 4.5.1) is a quick guide for locating the area of the problem. Part two (see 4.5.2) contains 10 tables which are given as detailed supplements to part one.

The following abbreviations are used:

Symbol	Meaning
B	Base (transistor)
C	Collector (transistor)
E	Emitter (transistor)
G	Gate (FET)
S	Source (FET)
D	Drain (FET)
CR	Diode
Qn	Transistor number (n)
V_{GS}	Voltage between gate and source (FET)
Q	Output terminal (flip-flop)
$\overline{Q}$	Inverting output terminal (flip-flop)

4.5.1 Quick Trouble-Shooting Guide

Symptom	Corrective Action
Blown Line Fuse	Replace fuse. If it blows again, check the following: 1. Solder bridge or wire connection shorted. 2. Q39 and/or Q40 shorted in output amplifier. 3. Bypass capacitors for power supply are shorted. 4. Follow Table 4-2 to locate the short in a particular power supply.
+15 V Power Supply Malfunctions	1. Voltage low: a. Transformer output low. b. Extra current loading. Check for overheated and defective component in the circuit. c. Q4 or Q3 is shorted. d. Q2 is open. e. CR10 is shorted. f. IC1 is defective. 2. Voltage high: a. Power transistor Q1 or Q2 is shorted. b. Q4 is open. c. IC1 is defective. 3. High frequency oscillation (MHz): a. C4 or C5 at IC1 is defective. b. One of the semiconductors in another part of the circuit is oscillating. Locate by using hand to touch the most sensitive area of the circuit boards. 4. Large 60 cycle noise: defective filter capacitor, C1 or C9.
Other Power Supply Malfunctions	1. Follow Table 4-2 to locate the problem to a particular power supply. 2. Use similar procedure for trouble-shooting as in the +15 V power supply malfunctions.

Quick Trouble-Shooting Guide (Continued)

Symptom	Corrective Action
MAIN GENERATOR	
No Output Signals	1. If no ∧∨ signal is present at output of ∧∨ amplifier (G of Q6), follow Table 4-3 for trouble-shooting. 2. Check for faulty wiring to and from FUNCTION selector (switch board). 3. If no signal is present at R238 and R241 with the ∧∨ FUNCTION selected, follow Table 4-10 to check out the X-Y multiplier and Table 4-5 to check out the output amplifier.
No ∧∨ , ⊓⊔ or SYNC Output	Follow Table 4-10 to check out the corresponding circuit.
⊓⊔ Rise/Fall Time Abnormally Slow	1. Malfunctioning ⊓⊔ amplifier. 2. One of the capacitors in the output amplifier is open. 3. C85 (output amplifier) is not calibrated.
Frequency Accuracy Out of Specification	1. Check frequency calibration. 2. Check for defective C34, C45 to C52, CR14 and/or CR16 on main board, if problem is in X 10K to X 1 MHz ranges. 3. Check capacitance multiplier, if problem appears in X 0.001 to X 1 ranges only, using Table 4-6. 4. Check VCG for frequency linearity problem in all ranges, using Table 4-4.
High Frequency Output Has Abnormal Ringing	Defective capacitor in output amplifier.
High Sine Distortion at Low Frequency	1. ∧∨ amplitude and time symmetry calibration is off. 2. Defective sine converter. 3. Sine converter or X-Y multiplier calibration is off.
High Sine Distortion at High Frequency	1. ⊓⊔ also looks bad, if problem is in the output amplifier. 2. Defective capacitors C34 and C45 to C52 in ∧∨ amplifier. 3. Defective C29 to C36 in sine amplifier. 4. Defective sine converter.
Unsymmetrical ∧∨	Follow Table 4-4 to check out VCG circuit.
Amplitude Accuracy Out of Specification	1. Check calibration. 2. Check X-Y multiplier, using Table 4-10.
TRIG and GATE MODE Inoperative	1. Check trigger and gated control switches. 2. Check for correct signals in the trigger circuit, using Table 4-9.
AUXILIARY GENERATOR	
No Aux Output Signal	1. If no ∧∨ is present at junction of R33 and R34, use Table 4-7. 2. If ∧∨ signal is present at junction of R33 and R34, check FUNCTION switch and wiring.
No Aux ∧∨ Output	1. If no ∧∨ signal is present at pin 4 of IC5 (±125 mV), check for defective sine converter (A1).

Quick Trouble-Shooting Guide (Continued)

Symptom	Corrective Action
No Aux ∿ Output (Cont)	2. If no ∿ signal is present at pin 12 of IC5 (±2.5 V peak), check for defective IC5 and associated circuitry. 3. If ∿ signal is present at pin 12 of IC5, check FUNCTION switch and wiring.
No Aux ⎍ Output	1. If no ⎍ signal is present at the emitter of Q22, check for defective IC7, Q20 – Q22 and associated circuitry. 2. If ⎍ signal is present at the emitter of Q22, check FUNCTION switch and wiring.
TRIG and GATE MODE Inoperative	1. Check trigger and gated control switches. 2. Use Table 4-7.

4.5.2 Trouble-Shooting Guide Tables

4.5.2.1 POWER SUPPLIES

Use Table 4-2 to localize the problem to a particular power supply and associated loading circuitry. In some cases, it is necessary to turn on the power of the unit no more than one or two seconds at a time to prevent it from blowing fuses and further damage circuit components.

NOTE

Be sure to use the correct ground in the following voltage checks.

Table 4-2. POWER SUPPLIES

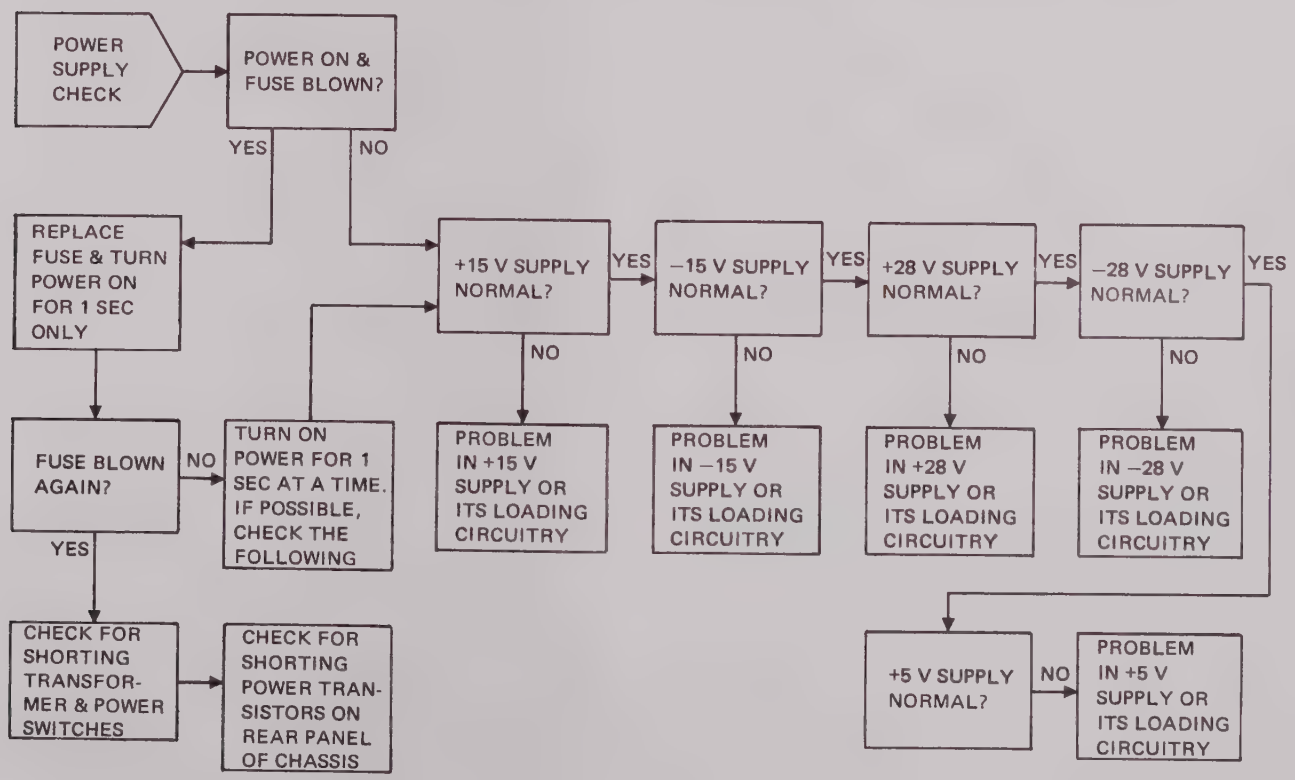


Table 4-3. TRIANGLE AMPLIFIER, COMPARATOR, AND HYSTERESIS SWITCH

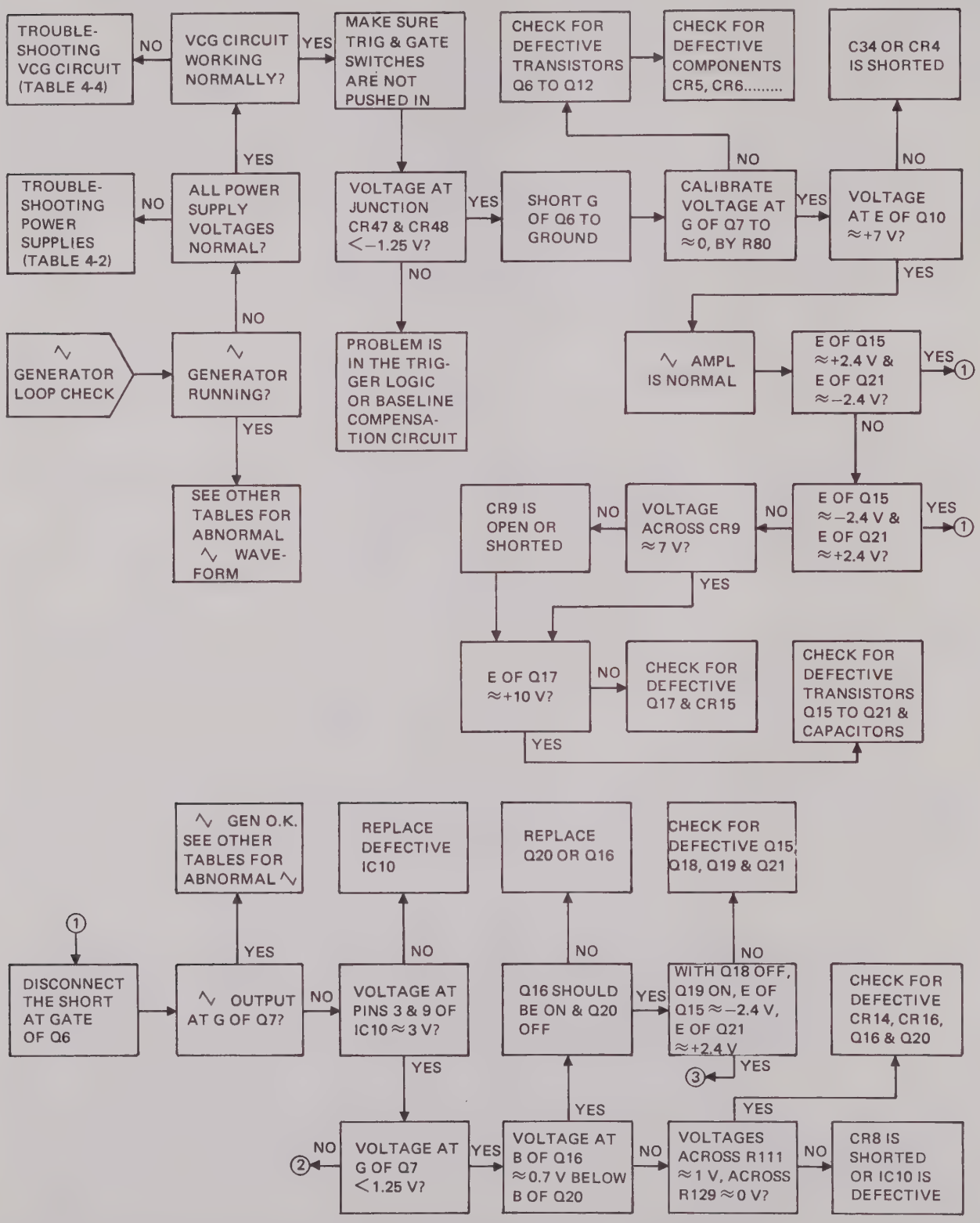


Table 4-3. TRIANGLE AMPLIFIER, COMPARATOR, AND HYSTERESIS SWITCH (Continued)

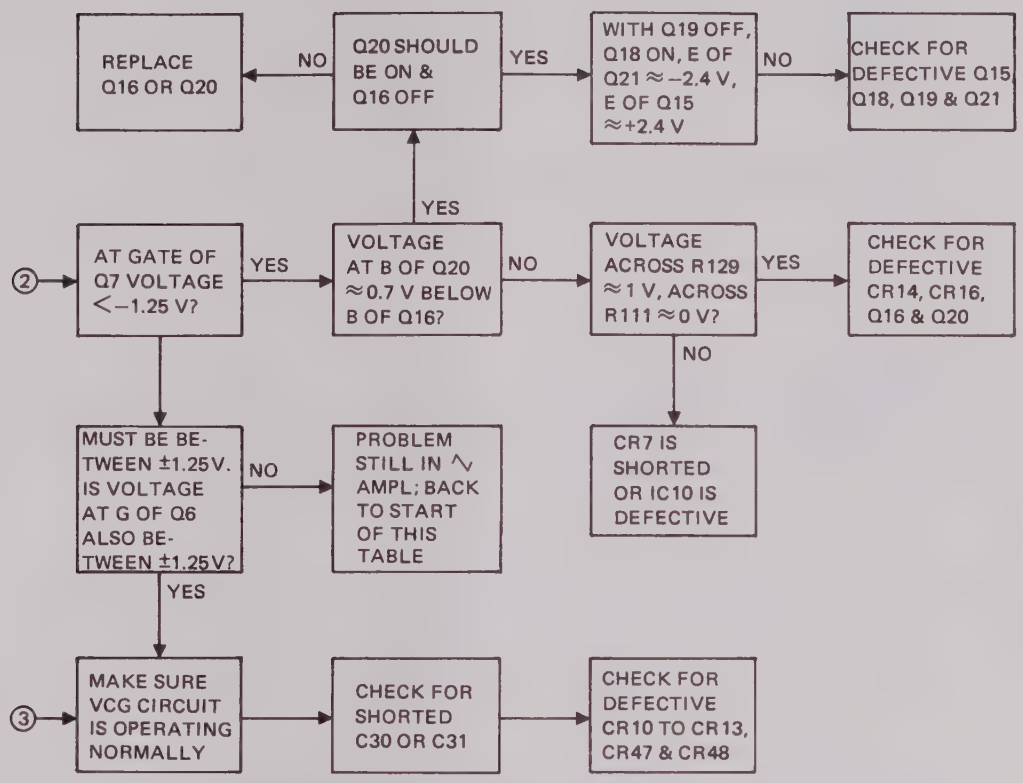


Table 4-4. VCG, CURRENT SOURCE, AND TRIG BASE LINE CORRECTOR

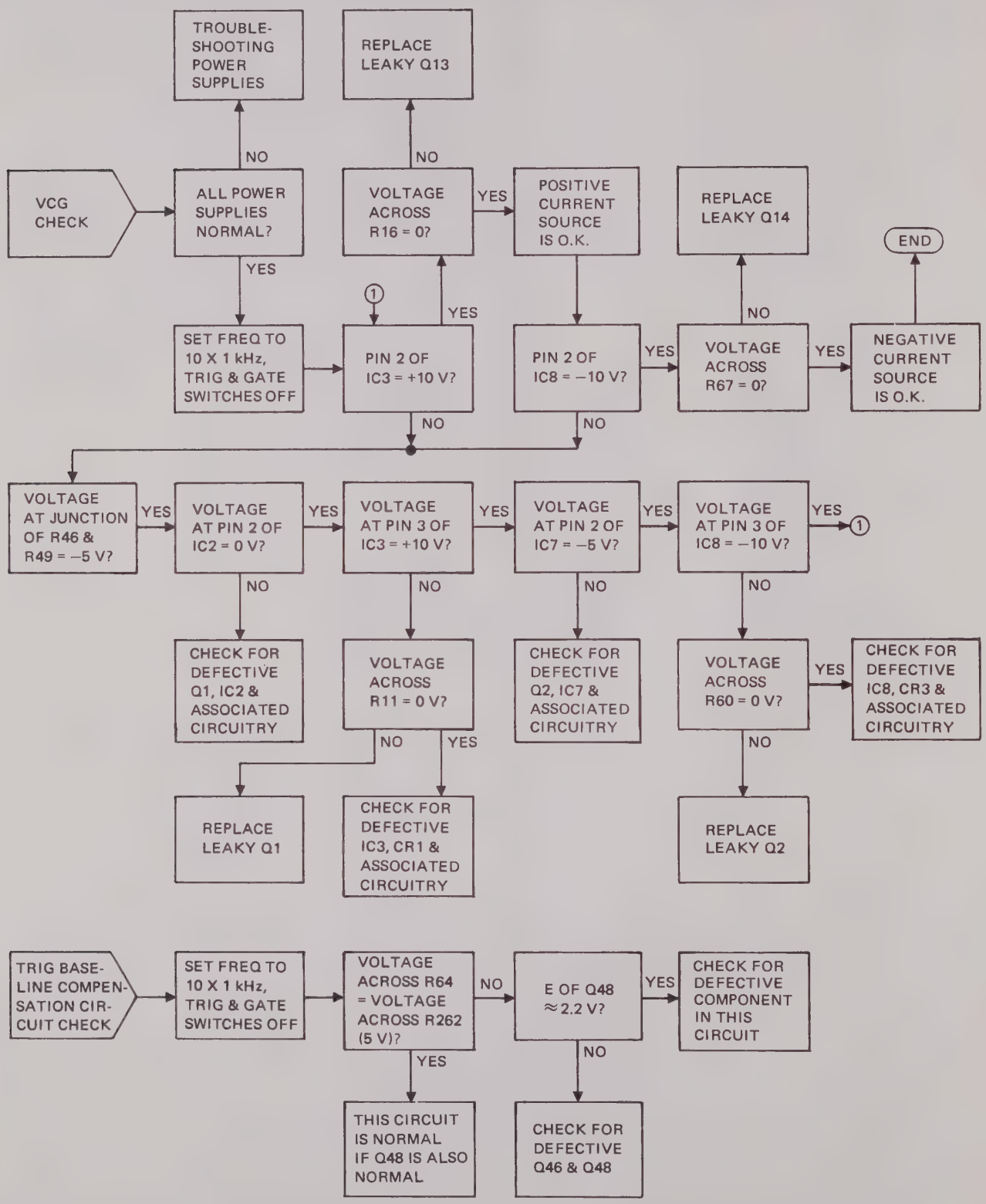


Table 4-5. OUTPUT AMPLIFIER

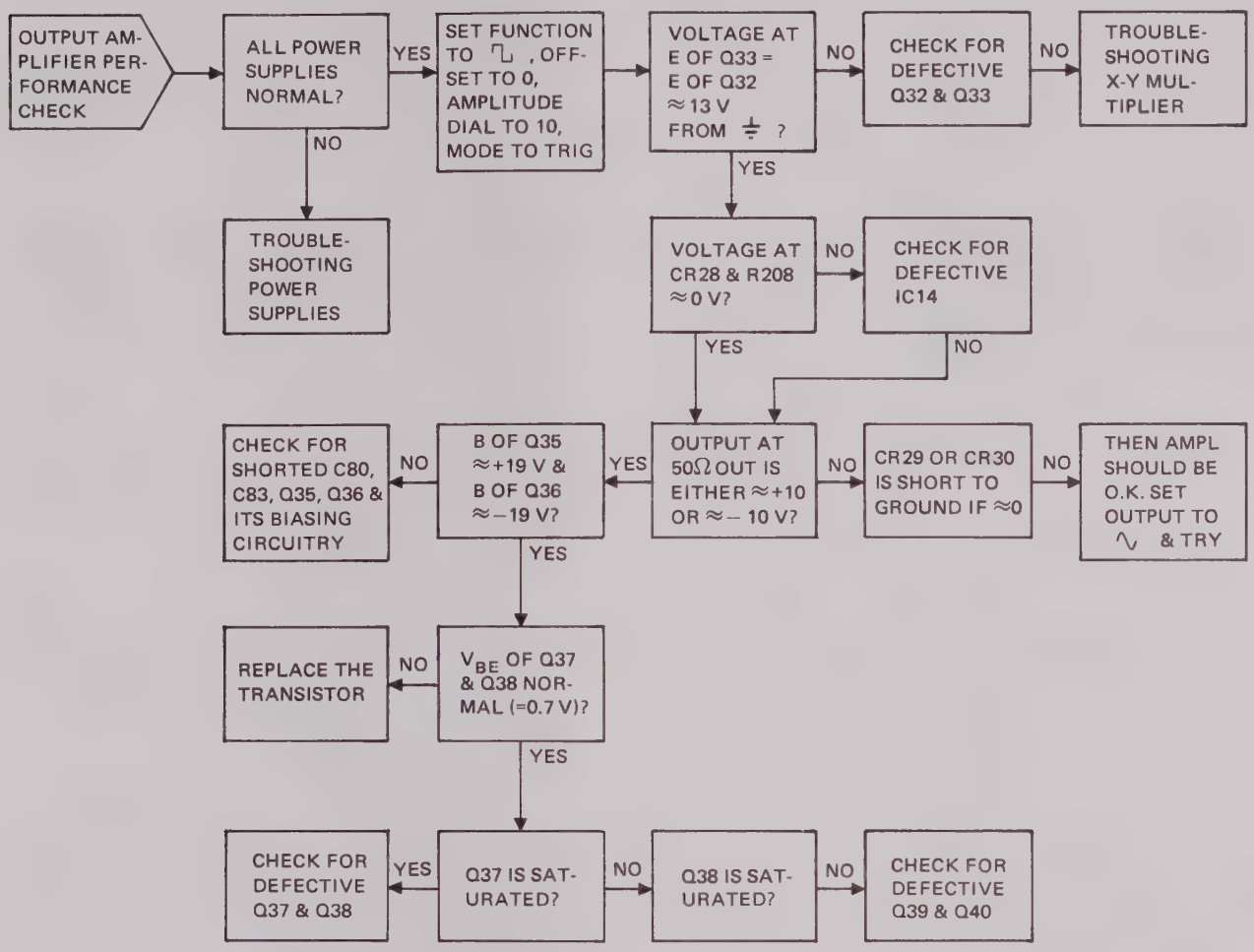


Table 4-6. CAPACITANCE MULTIPLIER

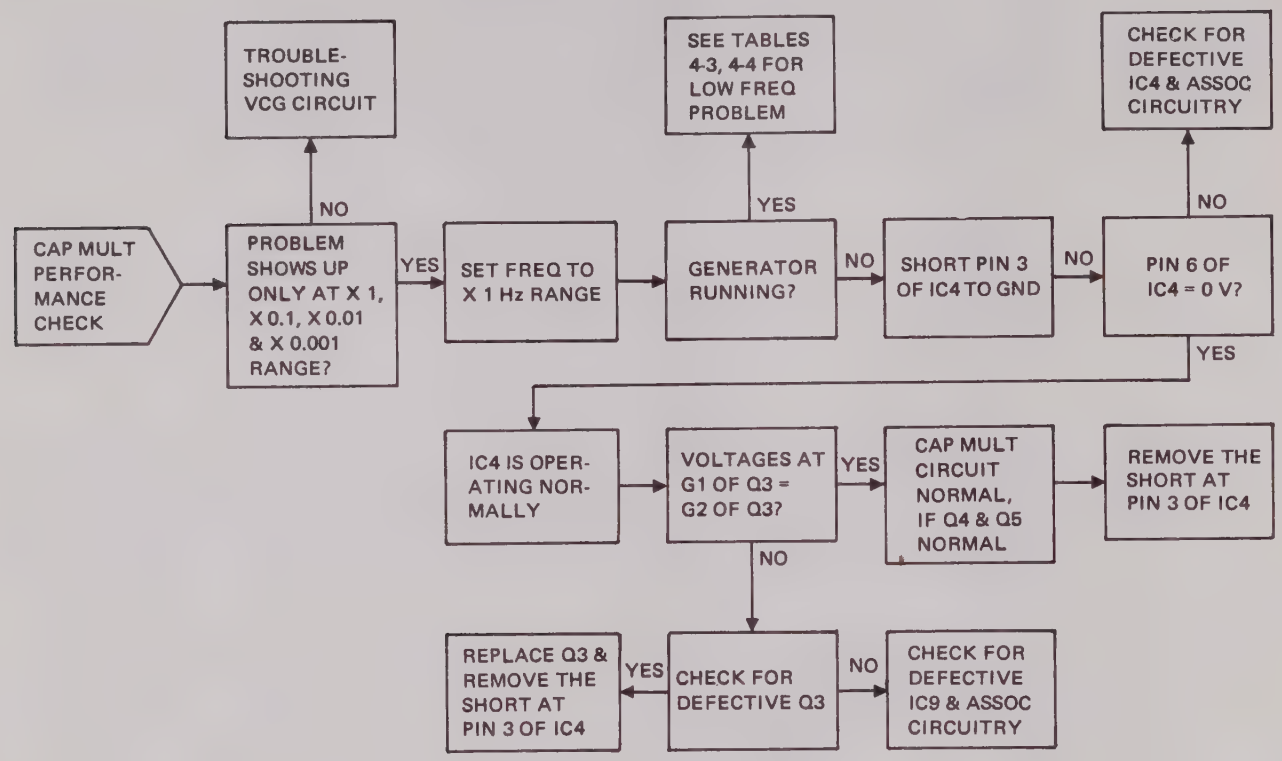


Table 4-7. AUXILIARY GENERATOR

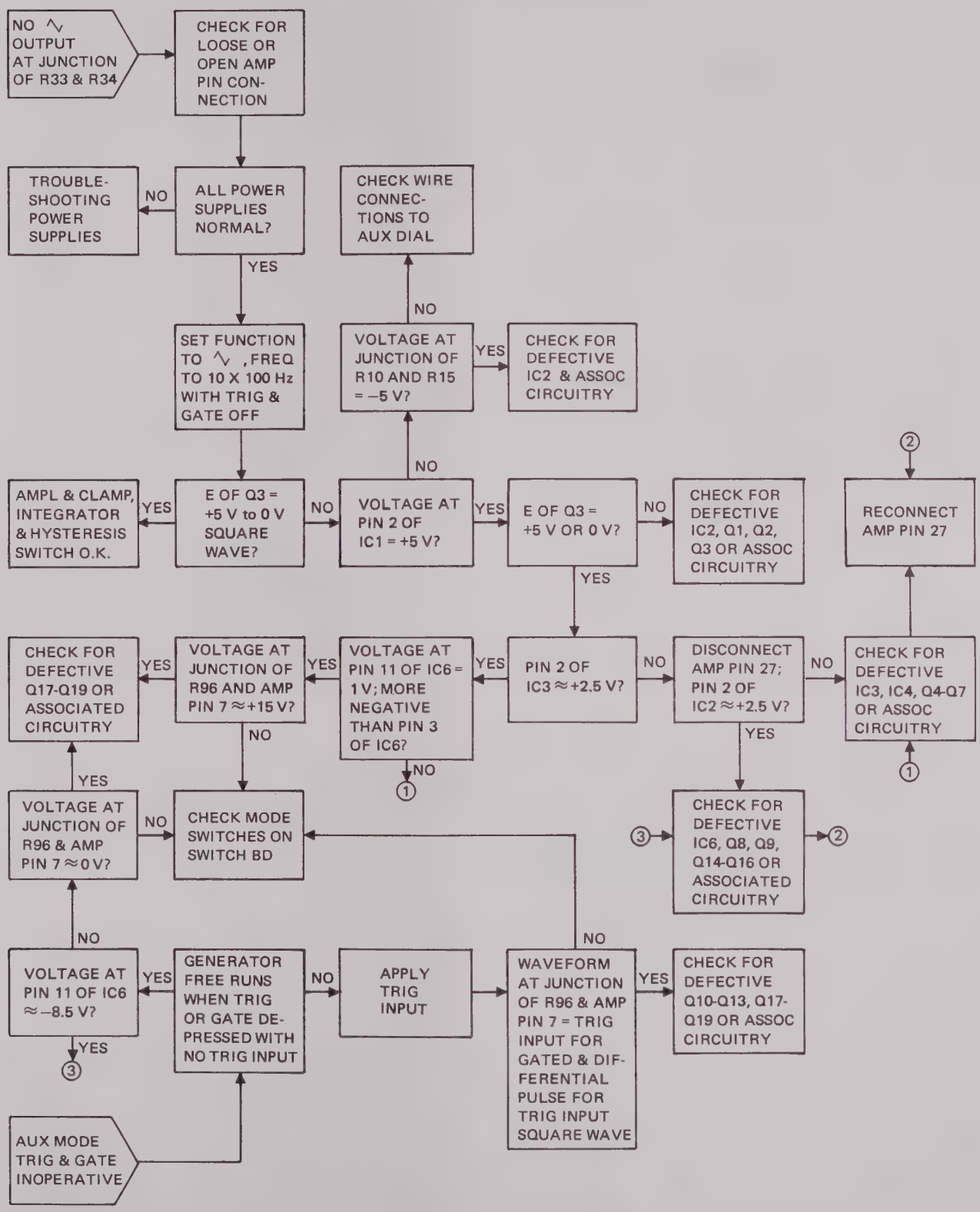
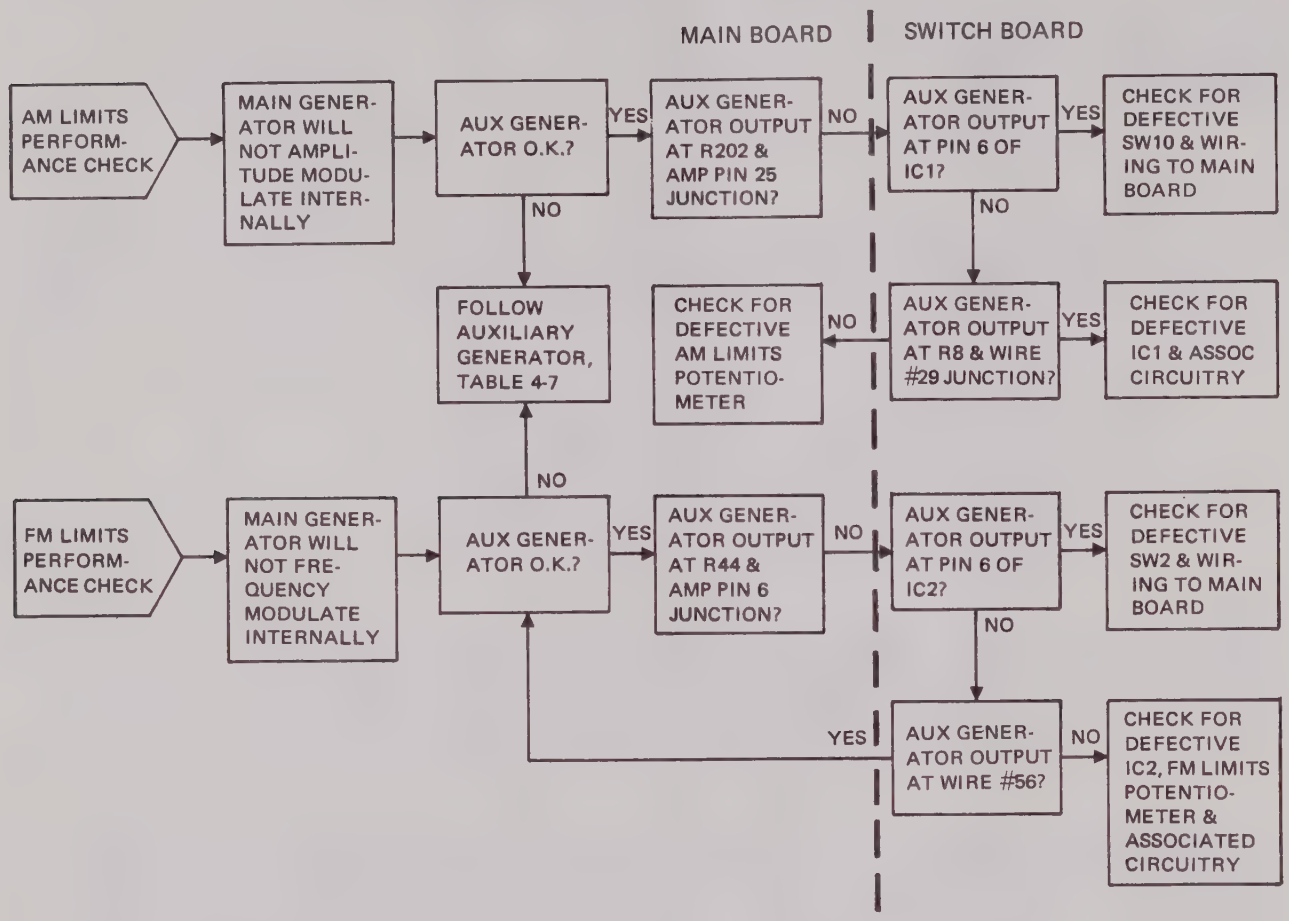


Table 4-8. AM LIMITS AND FM LIMITS CONTROLS



4.5.2.2 TRIGGER AND GATED LOGIC TIMING

For trouble-shooting the trigger, set the generator to the GATE MODE. (Refer to Table 4-9.) Draw a vertical line on the timing diagram along t_1 or t_2, depending on whether the TRIG IN signal is low or high, and check for correct voltage levels according to the timing diagram.

After the GATE MODE has been checked, the TRIG MODE can be checked in the same way, but concentrated in the Q55, Q56 area.

Table 4-9. TRIGGER AND GATED LOGIC TIMING DIAGRAM

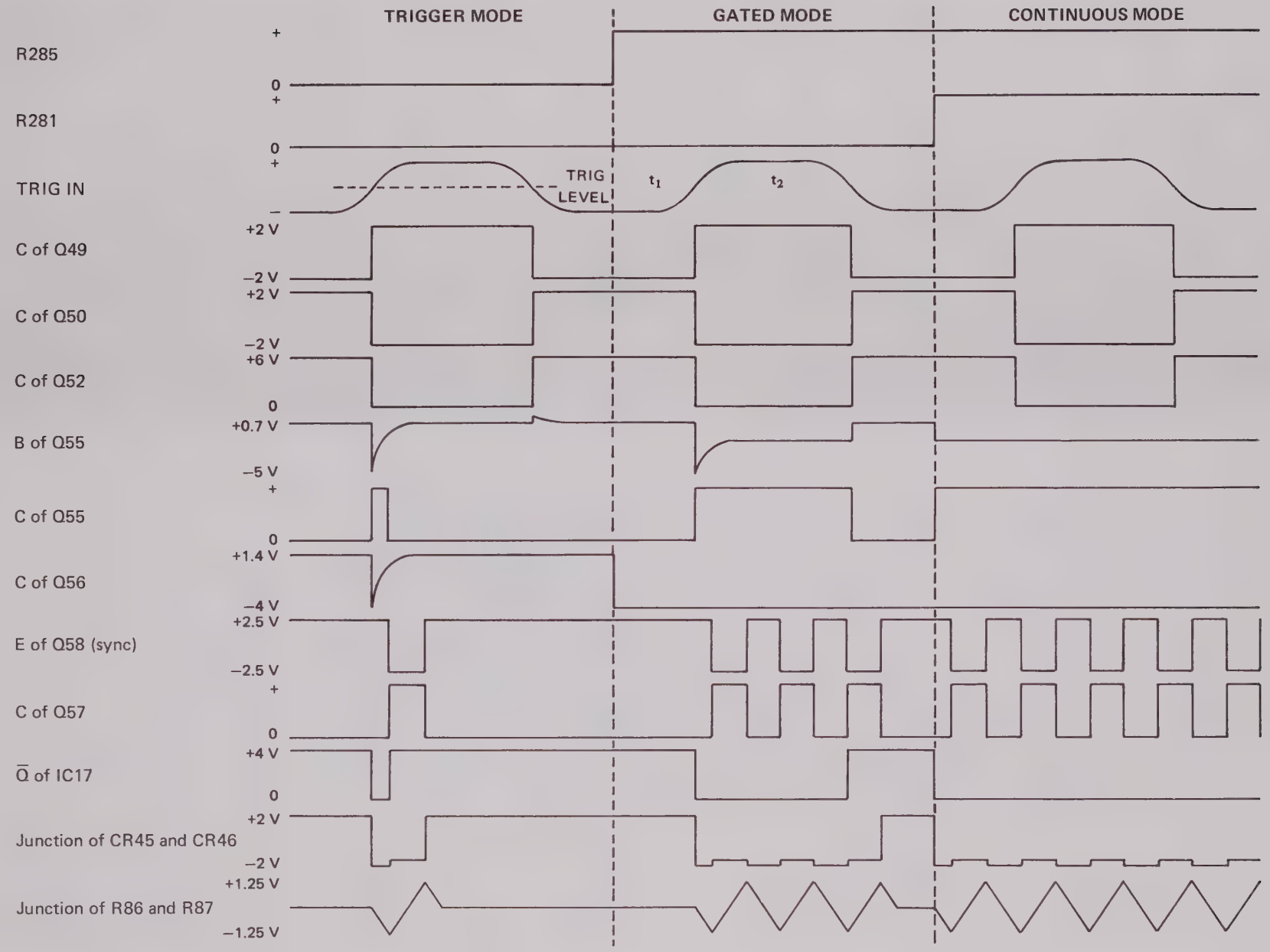


Table 4-10. KEY SIGNAL AND VOLTAGE

∿ AMPLIFIER, COMPARATOR AND HYSTERESIS SWITCH

Test Point	Typical Voltage
G of Q6	2.5 V p-p ∿ , 0 Vdc offset
G of Q7	2.5 V p-p ∿ , 0 Vdc offset
E of Q10	2.5 V p-p ∿ , ≈ +7 Vdc offset
Pins 1 and 4 of IC10	See Table 4-11.
Pins 2 and 8	−3 V
Pins 3 and 9	−3.7 V
E of Q16	+6.8 Vdc
B of Q16 and Q20	See Table 4-11.
E of Q15 and Q21	See Table 4-11.
E of Q17	+10 V
R118 and R125 junction	−3 V
S of Q13	+10 V to +15 V, dependent on frequency setting
S of Q14	−10 V to −15 V, dependent on frequency setting

X-Y MULTIPLIER

Test Point	Typical Voltage
R196	Selected signal (∿ , ∿ , ⊓⊔)
Pin 6 of IC11	+11 volts to −11 volts, dependent upon AMPLITUDE dial setting
Pin 6 of IC12	+2.5 volts to −2.5 volts, dependent upon AMPLITUDE dial setting
Pins 3 and 13 of IC13	−10.5 V
Pin 1 of IC13	Selected signal output +4 Vdc offset
E of Q32 and E of Q33	Selected signal output +13 Vdc offset amplitude dependent upon setting
Pin 14 of IC13	≈7 Vdc

∿ CONVERTER AND AMPLIFIER

Test Point	Typical Voltage
Pin 2 of A1	See Table 4-11.
Pin 4 of A1	+14 V
Pin 1 of A1	−14 V
Pin 5 of A1	250 mV p-p ∿ , 0 Vdc offset
R155 and R156 junction	2.5 V p-p ∿ , 0 Vdc offset
B of Q24 and Q25	+8 V

SYNC AND SQUARE AMPLIFIER

Test Point	Typical Voltage
R165 and R166 junction	±2 V ⊓⊔
CR23 cathode	±1.25 V ⊓⊔
R175 and R176 junction	±1.25 V ⊓⊔

OUTPUT AMPLIFIER

Test Point	Typical Voltage
B of Q35	+19 Vdc
E of Q37	+19 Vdc
B of Q36	−19 Vdc
E of Q38	−19 Vdc
R238 and R241 junction	Main output, ±10 V maximum

VCG AMPLIFIER AND TRIGGER BASELINE COMPENSATION

Test Point	Typical Voltage
Pin 6 of IC1	0 V to +5 V*
R46 and R49 junction	0 V to −5 V*
S of Q1	0 V
Pins 2 and 3 of IC3	+10 V to +15 V*
S of Q2	0 V to −5 V*
Pins 2 and 3 of IC7	−10 V to −15 V*
V_{GS} of Q46	$V_{G1,S1} = V_{G2,S2}$
R258 and R260	Voltage across both are equal
E of Q48	+2.2 V
R262	Voltage across R262 and R64 are equal

*Voltage is dependent on a FREQUENCY dial setting.

CAPACITANCE MULTIPLIER*

Test Point	Typical Voltage
G1 and G2 of Q3	±1.25 V ∿
Pin 6 of IC9	⊓⊔ , amplitude dependent on frequency setting
Pins 2 and 3 of IC4	±1.25 V ∿
Pin 6 of IC4	±7.5 V ∿

*The information applies if the frequency range is at X 1 Hz.

AUXILIARY GENERATOR (CONT MODE)

KEY SIGNALS AND VOLTAGES

Test Point	Typical Voltage
Pin 6 of IC2	0 V to +5 Vdc dependent on FREQUENCY dial setting
Pin 6 of IC1	0 Vdc
E of Q3	0 V to +5 Vdc step source dependent on FREQUENCY dial setting (see Figure 3-7 for correct step source).
Pin 13 of IC4	+1.25 Vdc
Pin 9 of IC4	−1.25 Vdc
C of Q6, pin 11 of IC4, pin 3 of IC1 and pin 3 of IC7	1 V p-p logic level, ≈ −3 Vdc offset 180° out-of-phase with logic level of C of Q7
C of Q7, pin 3 of IC4, pin 11 of IC1 and pin 11 of IC7	1 V p-p logic level, ≈ −3 Vdc offset 180° out-of-phase with logic level of C of Q6
Pin 3 of IC6	−7.5 Vdc
Pin 11 of IC6	−6.5 Vdc
R96 and AMP pin 7 junction	+15 Vdc
Pin 2 of IC7	+2.5 Vdc
Pin 6 of IC7	−2.5 Vdc
Pin 4 of IC5	±125 mV ∿
Pin 12 of IC5	±2.5 V ∿

∿ ∿ ⊓ FUNCTIONS ONLY

Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	≈ +2.5 V
R33 and R34 junction	±2.5 V ∿
E of Q22 and AUX OUT connector	±2.5 V ⊓

⟋ FUNCTION ONLY

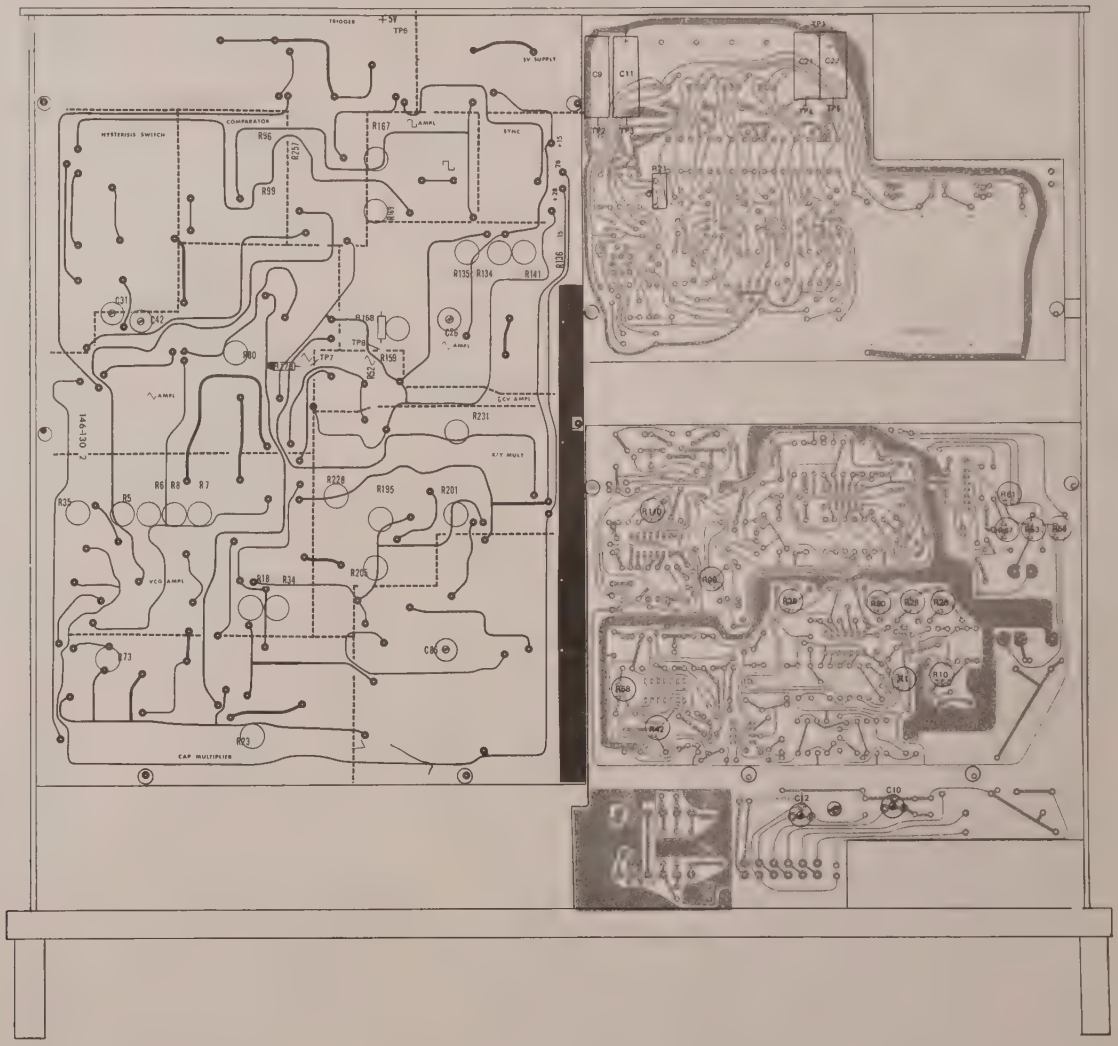
Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	≈ +0.1 V
R33 and R34 junction	±2.5 V ⟋
E of Q22 and AUX OUT connector	±2.5 V ⊔

⟍ FUNCTION ONLY

Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	+4.9 V
R33 and R34 junction	±2.5 V ⟍
E of Q22 and AUX OUT connector	±2.5 V ⊓

Table 4-11. KEY WAVEFORMS

Test Point	Waveforms
G of Q6 G of Q7	+1.25 V −1.25 V
Pin 1 of IC10	+0.7 V −0.5 V
Pin 4 of IC10	+0.5 V −0.7 V
B of Q16	+7 V +6.3 V
B of Q20	+7 V +6.3 V
E of Q15	+2.4 V −2.4 V
E of Q21	+2.4 V −2.4 V
CR12 Anode	+2 V −2 V
CR13 Cathode	+2 V −2 V
P2 of A1	+0.6 V −0.6 V
P5 of A1	+0.12 V −0.12 V
R155 and R156	+1.25 V −1.25 V


TRIGGER
+5V
TP6
5V SUPPLY
HYSTERISIS SWITCH
COMPARATOR
R96
R257
R99
R167
AMPL
SYNC
R135
R134
R141
R136
C31
C42
R158
TP8
C29
AMPL
R80
TP7
R150
R252
AMPL
R231
146-330-2
R/Y MULT
R6
R8
R7
R5
R35
R228
R195
R201
VCO AMPL
R18
R34
R205
C86
R73
R23
CAP MULTIPLIER
C9
C11
C21
C22
TP1
TP2
TP3
TP4
TP5
R21
R110
R61
R63
R64
R104
R38
R30
R28
R26
R68
R41
R10
R42
C12
C10

SECTION 5

DIAGRAMS ADDENDUMS AND PARTS LISTS

5.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

5.2 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit and, if applicable, the function performed.

5.3 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

CROSS REFERENCE FOR DRAWING NUMBERS

Drawings	Old Number	New Number
Chassis Assy	146-020	0102-00-0296
Chassis Schematic	146-220	0004-00-0037
Chassis Parts List	*	1101-00-0037
Main Board Assy	146-030	0101-00-0056
Main Board Schematic	146-230	0103-00-0056
Main Board Parts List	*	1100-00-0056
Power Supply Assy	146-011	0101-00-0057
Power Supply Schematic	146-211	0103-00-0057
Power Supply Parts List	*	1100-00-0057
Movement Assy	146-002	0102-00-0329
Left Movement Parts List	*	1101-00-0070
Right Movement Parts List	*	1101-00-0091
Switch Board Assy	146-032	0101-00-0058
Switch Board Schematic	146-232	0103-00-0058
Switch Board Parts List	*	1100-00-0058
Auxiliary Board Assy	146-033	0101-00-0059
Auxiliary Board Schematic	146-233	0103-00-0059
Auxiliary Board Parts List	*	1100-00-0059
Rear Panel Assy	146-014	0102-00-0330
Rear Panel Parts List	*	1101-00-0071
Trigger Switch Assy	146-005	1202-00-0015
Trigger Switch Parts List	*	*
Freq Hz Switch Assy	146-006	1202-00-0016
Freq Hz Switch Parts List	*	*
Attenuator Switch Assy	146-007	1202-00-0017
Attenuator Switch Parts List	*	*
D/C Offset Switch Assy	146-008	1202-00-0018
D/C Offset Switch Parts List	*	*
Freq/Period Switch Assy	146-009	1202-00-0019
Freq/Period Switch Parts List	*	*
Patch Block Assy	154-024	1205-00-0489
Patch Block Parts List	*	*

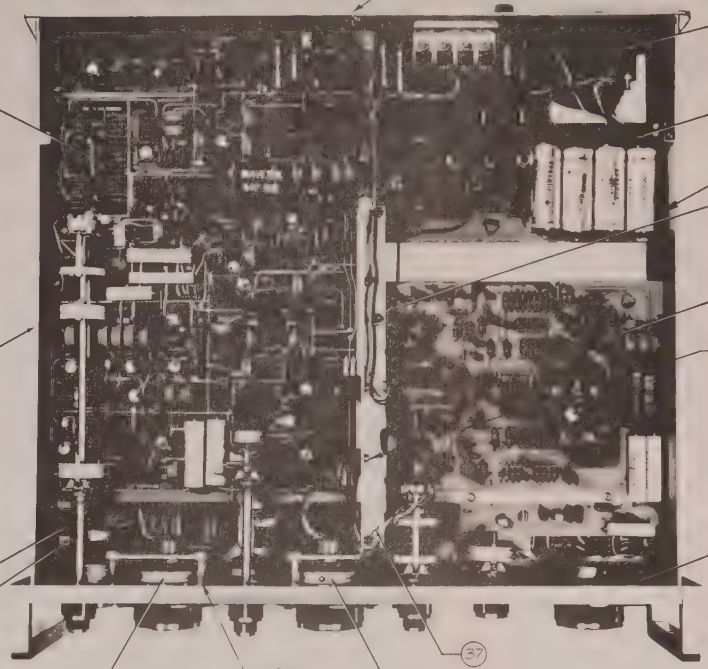
*Same as assembly number

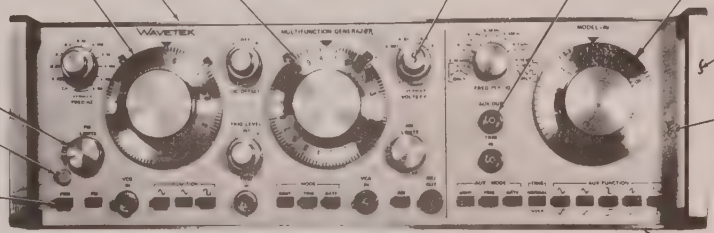
5.4 RECOMMENDED SPARE PARTS LIST

Information is provided to maintain the instrument on a board or component level. Price and delivery information should be obtained from the Wavetek representative in your area or directly from the factory.

DESCRIPTION	MFG	PART NO.	QTY
BOARD LEVEL			
MAIN BOARD	WAVETEK	146-030	1
POWER SUPPLY BOARD	WAVETEK	146-011	1
SWITCH BOARD	WAVETEK	146-032	1
AUXILIARY GENERATOR BOARD	WAVETEK	146-033	1
COMPONENT LEVEL			
DIODE	SEMTECH	SCE-1	2
DIODE	FAIRCHILD	FD777	1
DIODE	FAIRCHILD	FD6666	2
DIODE TUNNEL	GE	1N3716	1
DIODE ZENER	WAVETEK	1N4581	2
FUSE ¼A 230 V	LITTELFUSE	313-250	1
FUSE ½A 115 V	LITTELFUSE	313-500	
★INTEGRATED CKT – 13	FAIRCHILD	μA709C	2
★INTEGRATED CKT – 14	RCA	CA3054	1
★INTEGRATED CKT – 15	RCA	CA3030	1
INTEGRATED CKT	RCA	CA3028A	1
INTEGRATED CKT	RCA	CA3049	1
INTEGRATED CKT	FAIRCHILD	μA795	1
INTEGRATED CKT	NATIONAL	LM-301AN	1
INTEGRATED CKT	MOTOROLA	MC3050P	1
LAMP	MURA	L 28/40	1
SINE MODULE	WAVETEK	B142-011	1
TRANSISTOR	MOTOROLA	2N2905A	1
TRANSISTOR	FAIRCHILD	2N3638	2
TRANSISTOR	FAIRCHILD	2N3640	1
TRANSISTOR	FAIRCHILD	2N3642	2
TRANSISTOR	FAIRCHILD	2N3646	2
TRANSISTOR	MOTOROLA	2N3903	1
TRANSISTOR	MOTOROLA	2N3905	1
TRANSISTOR	FAIRCHILD	2N4047	1
TRANSISTOR	FAIRCHILD	2N4248	1
TRANSISTOR	FAIRCHILD	2N5139	1
TRANSISTOR	MOTOROLA	2N5160	1
★TRANSISTOR – 52	MOTOROLA	2N3563	2
★TRANSISTOR – 53	MOTOROLA	2N5485	2
★TRANSISTOR – 54	MOTOROLA	2N5485	1
★TRANSISTOR – 55	MOTOROLA	2N5462	1
★TRANSISTOR – 66	MOTOROLA	2N2219A	1
TRANSISTOR	MOTOROLA	MPS L08	1
TRANSISTOR	TEXAS INST	TIP 29	1
TRANSISTOR	TEXAS INST	TIP 30	1
TRANSISTOR	TECH PROD	TP 308	1

★Denotes special selected parts and should be ordered from Wavetek.





E	ECN 1764	LW	7-12-78	
D	ECN 1482	RD	9-5-78	
C	ECN 1335	RD	9-5-78	
B	ECN 1.60			
A	ECN 885			

tolerance unless otherwise specified XXX ± .010 XX ± .030	rev	ecn	by / date / app.
scale —	WAVETEK		San Diego, Calif
material -	by	date	app.
	title CHASSIS ASSY 0102-00-0296		
finish -	model no. 146	dwg no. 0102-00-0296	rev E

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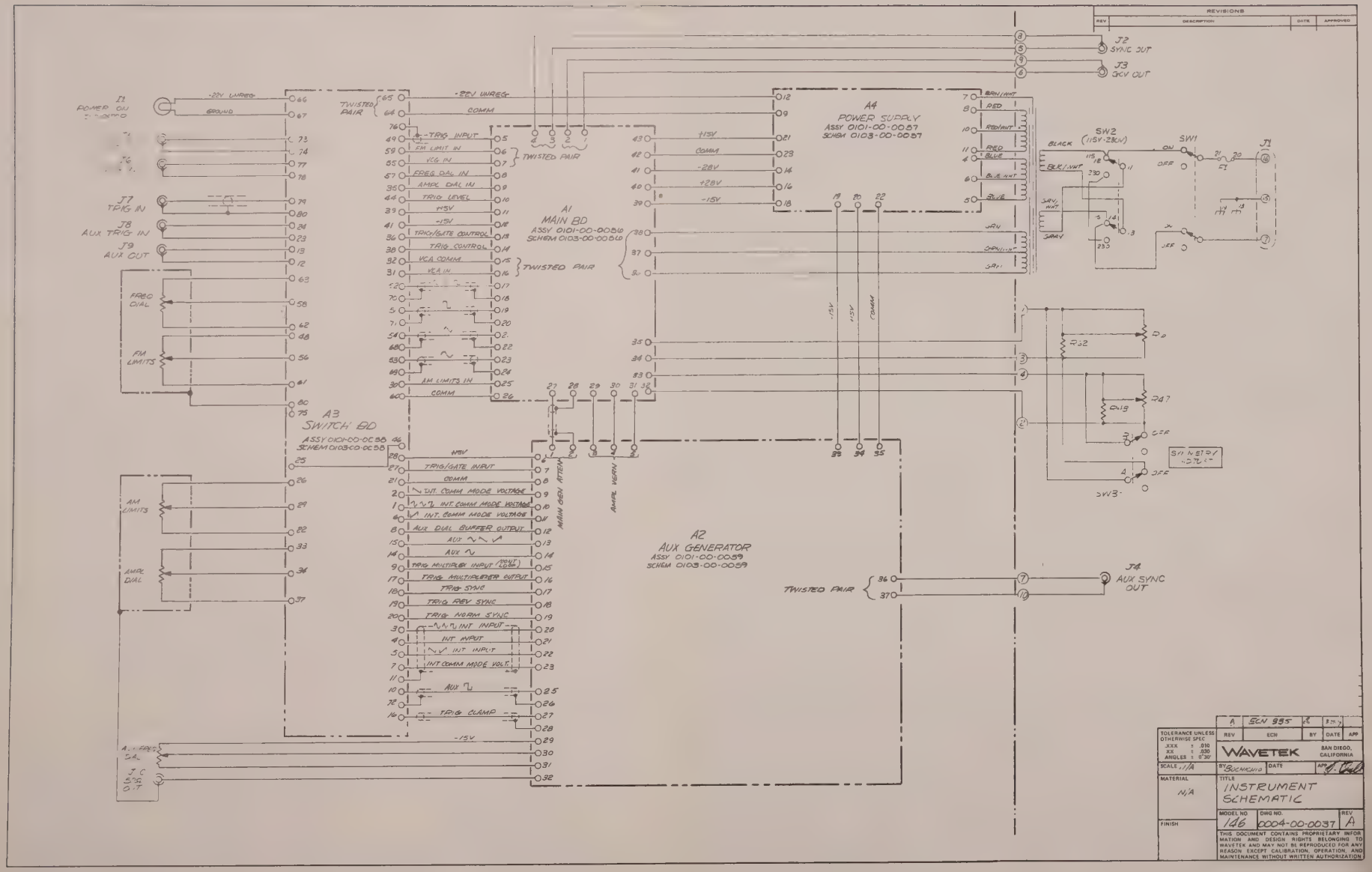
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
J2
SYNC OUT
J3
GCV OUT
A4
POWER SUPPLY
ASSY 0101-00-0057
SCHEM 0103-00-0057
A1
MAIN BD
ASSY 0101-00-0056
SCHEM 0103-00-0056
A3
SWITCH BD
ASSY 0101-00-0058
SCHEM 0103-00-0058
A2
AUX GENERATOR
ASSY 0101-00-0059
SCHEM 0103-00-0059
J1
POWER ON
J7
TRIG IN
J8
AUX TRIG IN
J9
AUX OUT
FREQ DIAL
FM LIMITS
AM LIMITS
AMPL DIAL
TWISTED PAIR
SW2
(115V-230V)
SW1
J1
J4
AUX SYNC OUT
SW3
TOLERANCE UNLESS OTHERWISE SPEC
.XXX ± .010
.XX ± .030
ANGLES ± 0°30'
WAVETEK
SAN DIEGO, CALIFORNIA
SCALE 1/A
MATERIAL
N/A
FINISH
TITLE
INSTRUMENT SCHEMATIC
MODEL NO
146
DWG NO.
0004-00-0037
REV
A
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REV	ECN	BY	DATE	APP

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY UNMG, CHASSIS	0102-00-0296	WVTK	0102-00-0296	1
20	DIAL ASSY	130-333-7	WVTK	1201-00-0011	1
C7	DIAL ASSY	130-333-8	WVTK	1201-00-0012	1
C5	DIAL ASSY	130-333-9	WVTK	1201-00-0013	1
NONE	COVER ASSY	146-COVER ASSY	WVTK	1201-00-0484	1
14	BAR,SUPT	146-305	WVTK	1400-00-2513	1
37	SHIELD,HEATSINK	146-337	WVTK	1400-00-2553	1
34	BRKT,SM	146-349	WVTK	1400-00-2583	1
21	PANEL,SUB	146-363	WVTK	1400-00-2653	1
15	PLATE,BLUE	146-364	WVTK	1400-00-2663	2
C3	PANEL,FT	146-366	WVTK	1400-00-2680	1
17	BAR,SUPT	146-371	WVTK	1400-00-2693	1
44	BLOCK,SPACER	146-372	WVTK	1400-00-2705	1
31	LEND,INDICATOR	154-311	WVTK	1400-00-2890	1
81	BRACE	157-304	WVTK	1400-00-3003	1
45 -54	MODULE,M/A FROM1.400-00-3304.	147-384	WVTK	1400-00-3584	6
43	LLAMP	147-316	WVTK	1400-00-3540	4

WAVETEK PARTS LIST | TITLE STD CHASSIS | ASSEMBLY NO. 1101-00-0037 | PAGE 1 | REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
V1	SWITCH ASSY PB	157-422	WVTK	5103-04-0011	.
93	BUTTON	J-52303-RED	CNL	5103-04-0006	.
NONE	PAN LUNU	0-7788-028-67	PMLRU	1001-00-0005	.

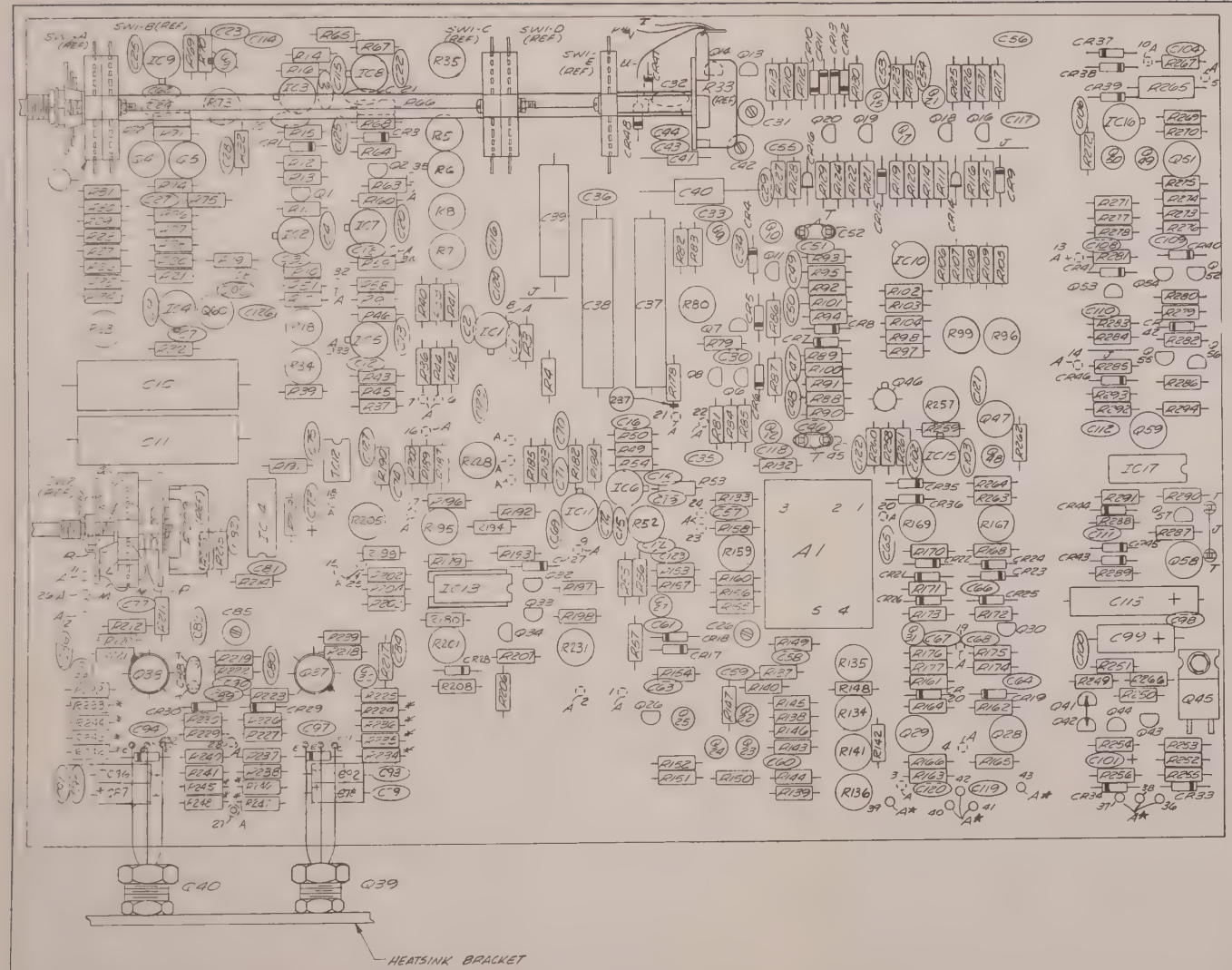
WAVETEK PARTS LIST | TITLE STD CHASSIS | ASSEMBLY NO. 1101-00-0037 | PAGE 3 | REV E

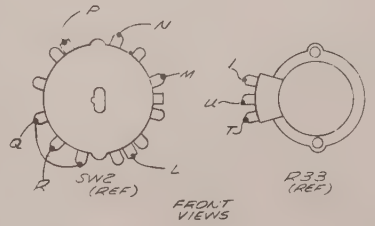
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
40	TRIM,MANDLE MFR13200-08-0006	147-343	WVTK	1400-00-3819	2
41	TRIM MFR13200-08-0005	1400-00-7019	WVTK	1400-00-7019	2
73	BNC LUNN	NC-7946	AING	2100-01-0002	6
71	BULDER LUG	1467	SMITH	2100-04-0012	6
51	BIU KNUB	KB-87-1-BBRN	HUGAN	2400-01-0008	3
44	CUBE KNUB BLT	KB-87-1-BBRU-H-4	HUGAN	2400-01-0004	4
65	BUMPING STLINER	SLDFF	TRUMA	2800-01-0002	5
84	SPACER	8839	SMITH	2800-02-0008	6
NONE	STANDOFF	8911-2-3C	LYNTR	2800-03-0003	4
NONE	INDERT,BANC,LOC	TR10100-8332	BOUTB	2800-04-0013	2
41	INDERT # 8	74-11-1040-18	BUTCU	2800-04-0016	2
NONE	PADT,CHASSIS	1391-C11	UBECU	2800-04-0022	11
35	WASHER,SHOULDER	2881	SMITH	2800-27-0002	3
87	WASHER,SHOULDER	2888	SMITH	2800-27-0004	6
84	NYLON FLAT WASHER	2864-4-4-385	SNIUM	2800-28-0005	6
87	RETAINING RING	5305-31	INURC	2800-38-0002	1

WAVETEK PARTS LIST | TITLE STD CHASSIS | ASSEMBLY NO 1101-00-0037 | PAGE 2 | REV E

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROTNBR		TITLE STD CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX .010 ANGLES ± XX .02		
	DO NOT SCALE DWG	MODEL NO	DWG NO 146-000 1101-00-0037 REV E
	SCALE	CODE IDENT NO. 23338	SHEET OF





REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

REV	ECN	BY	DATE	APP
F	ECN 1394			
E	ECN 1337			
D	ECN 1211			
C	1057			
B	920			
A	ECN 797			

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'

SCALE 2/1

MATERIAL –

FINISH –

WAVETEK SAN DIEGO CALIFORNIA

BY REDMAN DATE 9-14-73 APP

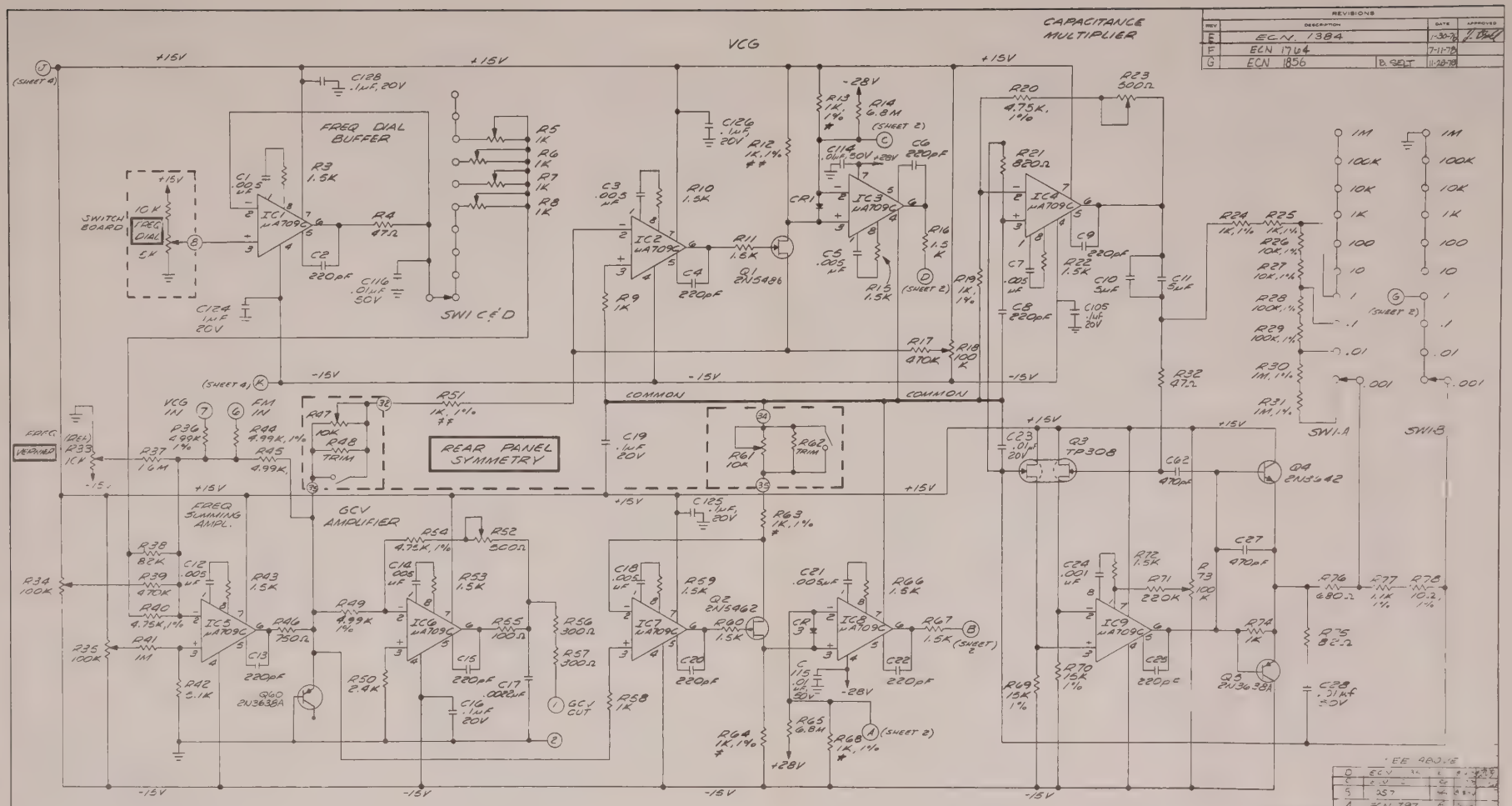
TITLE ASSY MAIN BOARD

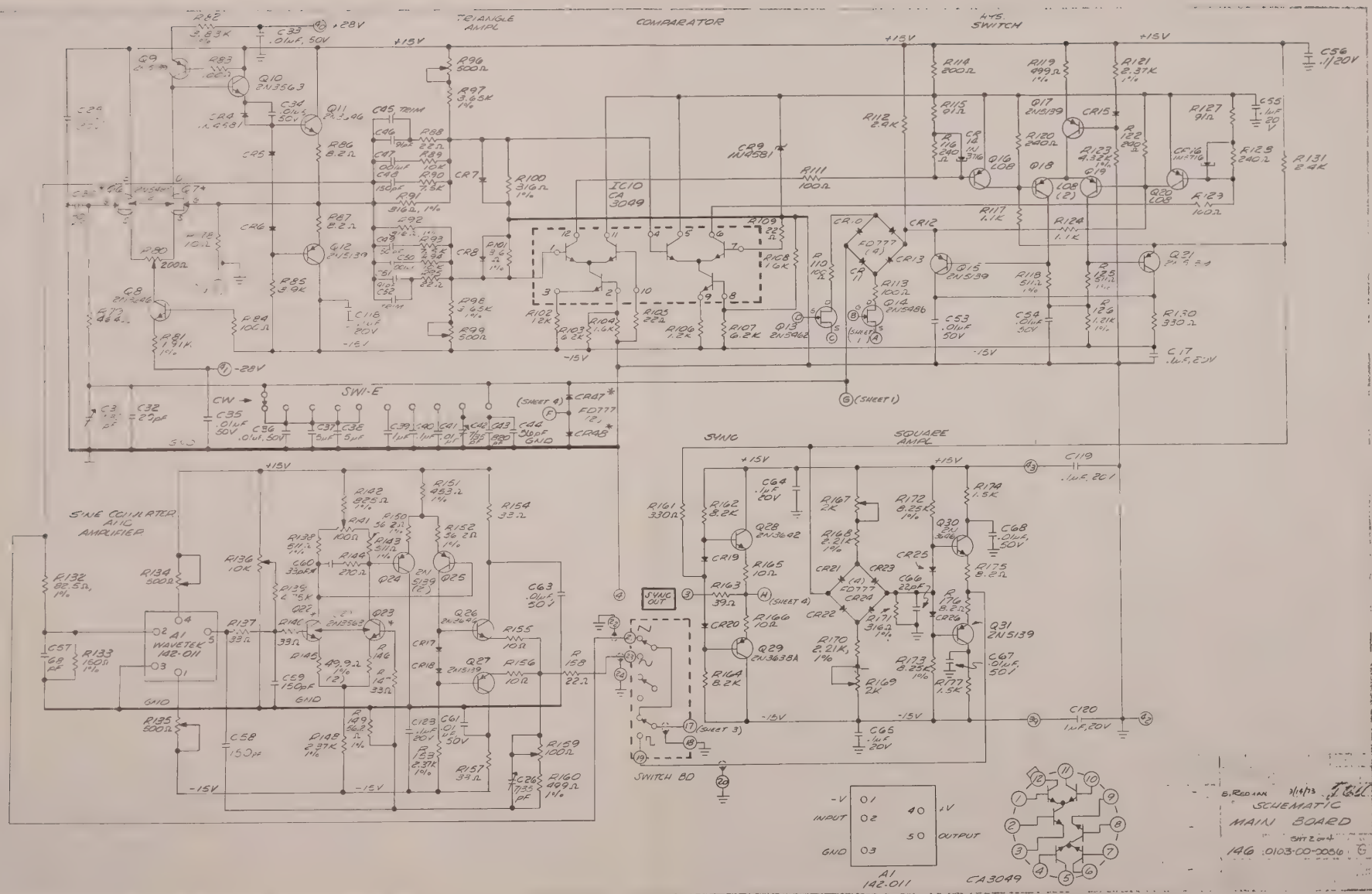
MODEL NO 146 DWG NO 0101-00-0056 SHEET 1 OF 1 REV F

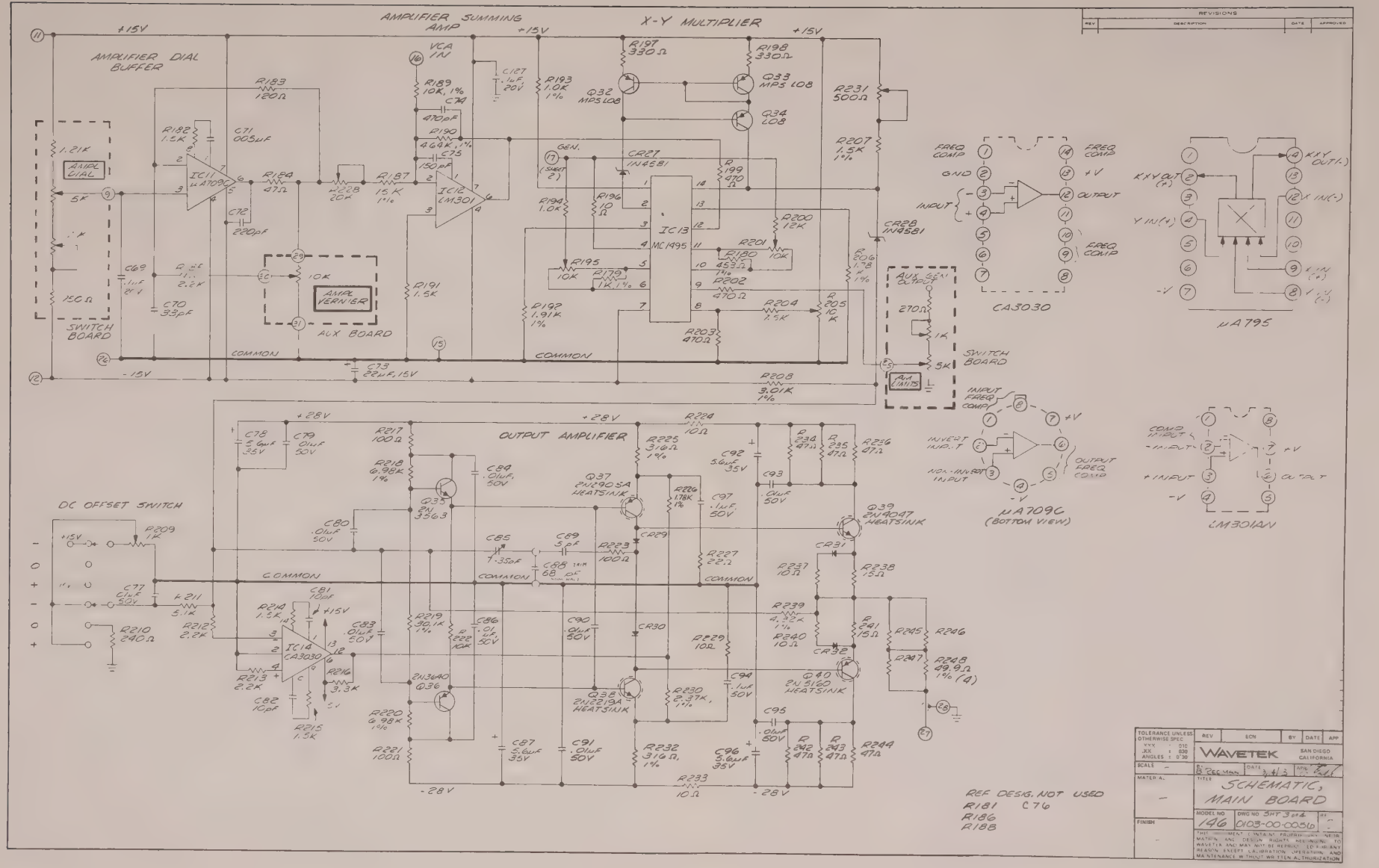
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION

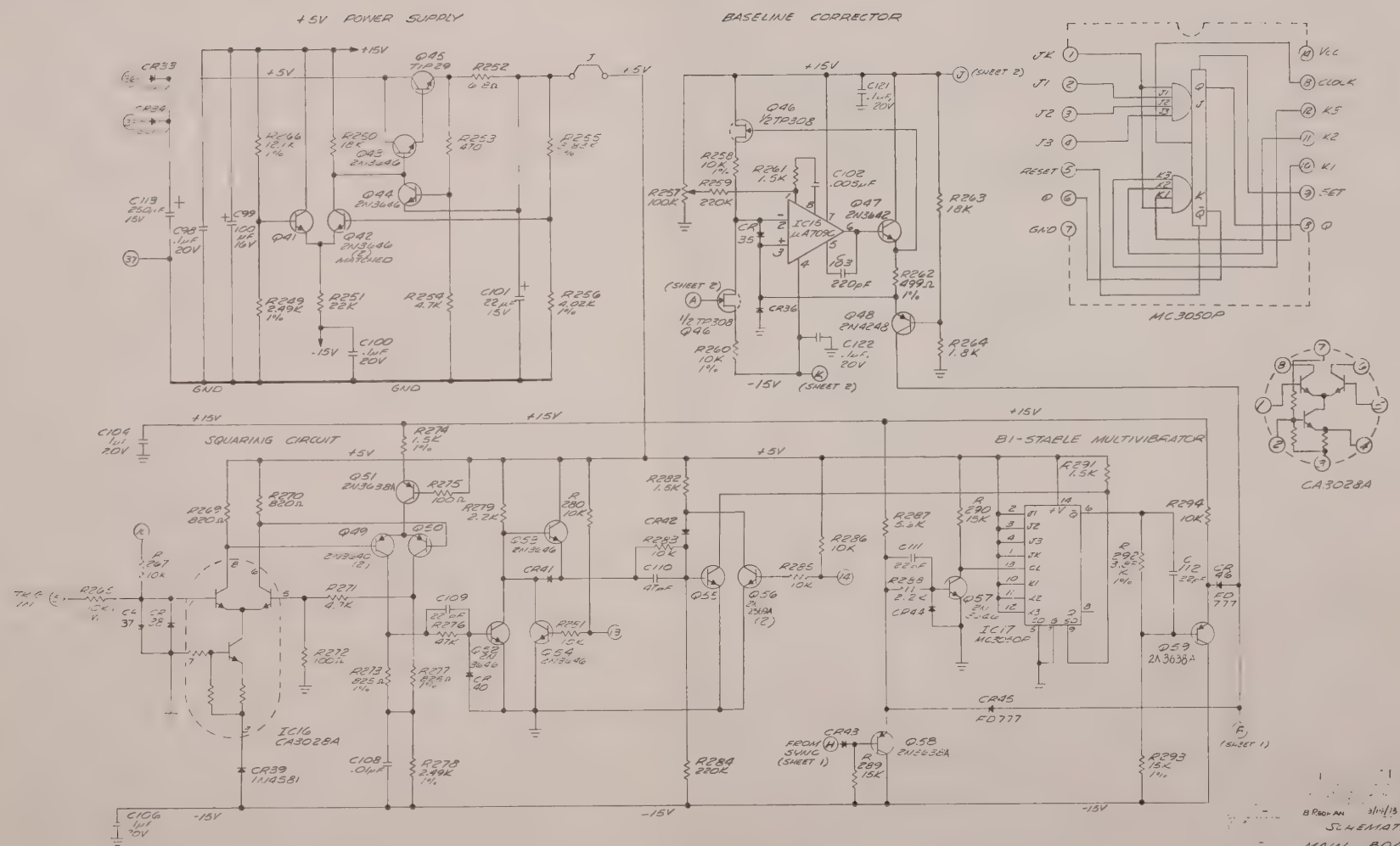
NOTES: UNLESS OTHERWISE SPECIFIED

1. A★ INDICATES AMP PINS MOUNTED ON COMPONENT SIDE
2. ★ INDICATE RESISTOR WITH CRIMPE LEADS, TO BE MOUNTED OFF BOARD SURFACE (12)
3. INSTALL CBB ON BIFURCATED TERMINALS (200081)


CAPACITANCE MULTIPLIER
VCG
FREQ DIAL BUFFER
SWITCH BOARD
SW1 C & D
REAR PANEL SYMMETRY
COMMON
FREQ SUMMING AMPL.
GCV AMPLIFIER
SW1-A
SW1-B
+15V
-15V
-28V
+28V
(SHEET 2)
(SHEET 4)
(SHEET 1)
GC1 CUT
FREQ COMP OUTPUT
OUTPUT
+Vcc
-Vcc
INPUT
FREQ COMP INPUT
μA709C (BOTTOM VIEW)
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
E
ECN 1384
1-30-78
F
ECN 1764
7-11-78
G
ECN 1856
B. SELT
11-28-78
TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'
SCALE —
MATERIAL —
FINISH —
WAVETEK
SAN DIEGO, CALIFORNIA
TITLE
SCHEMATIC, MAIN BOARD
MODEL NO 146
DWG NO 0103-00-00510
REV
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION
REF DESIG. NOT USED
R1, R2, CR2
LAST REF DESIG.
R294 CR48
C128 Q60
IC17 SW1
A1
2. ALL DIODES ARE 1N6666
1. ALL RESISTORS ARE CARBON, 1/2W, 10%
NOTES: UNLESS OTHERWISE SPECIFIED


TRIANGLE AMPL
COMPARATOR
+45 SWITCH
SWI-E
SINE COUNTER
A1C AMPLIFIER
SYNC
SQUARE AMPL
SWITCH BD
IC10 CA 3049
A1 WAVETEK 142-011
INPUT
GND
OUTPUT
CA3049
SCHEMATIC
MAIN BOARD
146 0103-00-0056


AMPLIFIER SUMMING AMP
X-Y MULTIPLIER
AMPLIFIER DIAL BUFFER
SWITCH BOARD
AMPL DIAL
AMPL VERNIER
AUX BOARD
IC11 μA709C
IC12 LM301
IC13 MC1495
COMMON
+15V
-15V
VCA IN
GEN.
AUX GEN OUTPUT
AUX GEN INITS
CA3030
μA795
μA709C (BOTTOM VIEW)
LM301AN
OUTPUT AMPLIFIER
DC OFFSET SWITCH
IC14 CA3030
+28V
-28V
REF DESIG. NOT USED
R181 C76
R186
R188
WAVETEK
SAN DIEGO CALIFORNIA
SCHEMATIC, MAIN BOARD
MODEL NO. 146
DWG NO 5HT 3 of 4
0103-00-00506


+5V POWER SUPPLY
BASELINE CORRECTOR
SQUARING CIRCUIT
BI-STABLE MULTIVIBRATOR
MC3050P
CA3028A
IC16 CA3028A
IC17 MC3050P
IC18 μA709C
DESIGNATORS NOT USED
R268 C105, C107
SCHEMATIC, MAIN BOARD
146 0103-00-0036 G

REV	ECN	BY	DATE	APP

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG, MAIN	0101-00-0056	WVTK	0101-00-0056	1
NONE	SCHEMATIC, MAIN	0101-00-0056	WVTK	0101-00-0056	1
A1	SINK MOD	142-011	WVTK	1200-00-0002	1
SW1	FREQ SW ASSY	146-006	WVTK	1202-00-0016	1
SW2	D/C OFFSET SW ASSY	146-008	WVTK	1202-00-0018	1
IC17	PATCH BLOCK	150-024	WVTK	1205-00-0049	1
NONE	SPACER	4440	WVTK	1400-00-0653	1
C89	CAP,CER,5MF,1KV	DD-650	CWL	1500-00-5011	1
C81 C82	CAP,CER,10PF,1KV	DD-100	CWL	1500-01-0011	2
C24 C47 C50	CAP,CER,.001MF,1KV	DD-102	AMCO	1500-01-0211	3
C108 C114 C116 C118 C23 C24 C33 C34 C35 C36 C53 C54 C61 C63 C67 C68 C77 C79 C80 C83 C84 C86 C90 C91 C93 C95	CAP,CER,.01MF,50V	CK-103	CDL	1500-01-0310	26
C94 C97	CAP,CER,.1MF,50V	CK-104	CDL	1500-01-0410	2
C100 C104 C105 C106 C117 C118 C119 C120 C121 C122 C123 C124 C125 C126 C127 C128 C16 C19 C29 C55 C56	CAP,CER,.1MF,20V	UK20-104	CDL	1500-01-0413	25

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 1 — REV G

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C99	CAP,ELECT,100MF,16V	5000107G016DF7	SPRAG	1500-31-0101	1
C113	CAP,ELECT,250MF,16V	5000257G016DF7	SPRAG	1500-32-5101	1
C41	CAP,POLYC,.01MF,100V	P42H103K	ELCUB	1500-41-0104	1
C40	CAP,POLYC,.1MF,100V	P42H104K	ELCUB	1500-41-0404	1
C39	CAP,POLYC,1MF,100V	21M-81C-105F	IMC	1500-41-0504	1
C10 C11 C57 C58	CAP,POLYC,5MF,100V	C14E5MF	ELPAC	1500-45-0504	4
C26 C31 C42 C45	VARI,7-35PF,250V	73-TW1K0-A2 7/45 PF	TRIKO	1500-53-5000	4
C101 C73	CAP,TANT,22MF,15V	196D226X0015KB1	SPRAG	1500-72-2401	2
C7A C87 C92 C96	CAP,TANT,5.6MF,35V	150D565X9035B2	SPRAG	1500-75-6502	4
NONE	MAIN	106-130	WVTK	1700-00-0056	1
NONE	SKT,IC,14PIN	14-DIP	CINCH	2100-01-0011	1
NONE	TERM	200041	DSECO	2100-05-0004	6
NONE	TERM	200041	DSECO	2100-05-0010	43
NONE	CONN	6050H-8	AMP	2100-05-0017	6
NONE	PIN,MALE	61192-2	AMP	2100-05-0020	43
NONE	HEAT SINK	WF-207	LAKE	2800-11-0001	2
NONE	TRANSIPAD	10120A	MIRS	2800-11-0003	2

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 3 — REV G

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R265	RES,C,1W,10%,10M	RC32GF-103	STPKP.	4700-35-1002	1
R110 R111 R113 R124 R217 R221 R223 R272 R275 R55 R83 R82	RES,MF,1/4W,1%,100	RN55 -1000F	IRC	4701-03-1000	12
R179 R19 R193 R194 R58 R74 R9	RES,MF,1/4W,1%,1K	RN550-1001F	IRC	4701-03-1001	7
R189 R222 R256 R260 R267 R280 R281 R283 R285 R286 R290 R80 R90	RES,MF,1/4W,1%,10K	RN550-1002F	IRC	4701-03-1002	15
R155 R156 R184 R186 R178 R196 R220 R237 R248 R76	RES,MF,1/4W,1%,10	RN550-10R0F	IRC	4701-03-1009	[illegible]
R117 R124 R77	RES,MF,1/4W,1%,1.1K	RN550-1101F	IRC	4701-03-1101	3
R102 R106 R126	RES,MF,1/4W,1%,1.21K	RN550-[illegible]	IRC	4701-03-1211	3
R268 R266	RES,MF,1/4W,1%,12.1K	RN550-[illegible]	IRC	4701-03-1212	2
R185	RES,MF,1/4W,1%,12K	RN550-1202F	IRC	4701-03-1202	1
R135	RES,MF,1/4W,1%,15K	RN550-1502F	IRC	4701-03-1500	1
R10 R11 R15 R16 R178 R177 R182 R191 R207 R214 R215 R22 R261 R274 R282 R291 R3 R45 R53 R59 R60 R66 R67	RES,MF,1/4W,1%,1.5K	RN550-1501F	IRC	4701-03-1501	24

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 5 — REV

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C60 C65 C69 C98					
C58 C75	CAP,CER,150PF,1KV	DD-151	AMCO	1500-01-5111	2
C109 C111 C112 C66	CAP,CER,.002[illegible]	DD-202	AMCO	1500-02-2011	4
C103 C13 C15 C2 C20 C22 C25 C4 C6 C72 C8 C9	CAP,CER,220PF,1KV	DD-221	AMCO	1500-02-2111	12
C17	CAP,CER,.0022,1KV	DD-222 LONG LEAD	CWL	1500-02-2201	1
C60 C70	CAP,CER,[illegible]	DD-332	AMCO	1500-03-3011	2
C110	CAP,CER,.07MF,1KV	DD-673	AMCO	1500-06-7011	1
C27 C62 C74	CAP,CER,.470MF,1KV	DD-473	AMCO	1500-06-7111	3
C1 C102 C12 C14 C18 C21 C3 C5 C7 C71	CAP,CER,.005MF,50V	CK-502	CDL	1500-05-0210	10
C57 C88	CAP,CER,6.8MF,1KV	DD-685	CWL	1500-06-8001	2
C88 C89 C59	CAP,MICA,1500PF,500V	DM15-152J	AMCO	1500-11-5100	3
C32	CAP,MICA,20PF,500V	DM15-20RJ	ARCO	1500-12-0000	1
C30	CAP,MICA,30PF,500V	DM15-300J	AMCO	1500-13-0000	1
C44	CAP,MICA,6.8PF,500V	DM15-6R0J	AMCO	1500-16-8000	1
C43	CAP,MICA,820PF,500V	DM15-821F	AMCO	1500-18-2101	1
C46 C51	CAP,MICA,910PF,500V	DM15-910J	AMCO	1500-19-1000	2

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 2 — REV G

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	TRANSIPAD	10160	MIRS	2800-11-0004	2
NONE	HEATSINK NUT	11016	THERM	2800-11-0005	4
NONE	HEATSINK BODY	11034	THERM	2800-11-0006	2
NONE	FERRITE BEAD	56-590-65/3B	FERRX	5100-00-0001	[illegible]
R141 R159	POT,TWIM,100	91A100	ARCK	4400-01-0103	2
R5 R6 R7 R8	POT,TWIM,1K	91A1K	ARCK	4400-01-0204	4
R136 R195 R201 R203	POT,TWIM,10K	91A10K	ARCK	4400-01-0315	4
R14 R257 R59 R35 R75	POT,TWIM,100K	91A[illegible]	ARCK	4400-01-0402	5
R80	POT,TWIM,200	91A200	ARCK	4400-02-0101	1
R167 R169	POT,TWIM,2K	91A2K	ARCK	4400-02-0201	2
R228	POT,TWIM,20K	91A[illegible]	ARCK	4400-02-0301	1
R138 R135 R23 R231 R52 R96 R99	POT,TWIM,500	91A500	ARCK	4400-05-0100	7
R224 R233	RES,C,1/2W,5%,1K	RC20GF-102	STKPL	4700-25-0100	2
R252	RES,C,1/2W,5%,6.8	RC20GF-6R8	STKPL	4700-25-0680	[illegible]
R175 R176 R86 R87	RES,C,1/2W,5%,8.2	RC20GF-8R2	STKPL	4700-25-0820	4
R37	RES,C,1/2W,5%,1.8M	RC20GF-185	STKPL	4700-25-1800	1
R18 R65	RES,C,1/2W,10%,6.8M	RC20GF-685	STKPL	4700-25-6800	2

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 4 — REV G

REFERENCE DESIGNATIONS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R72					
R187 R289 R290 R295 R69 R78	RES,MF,1/4W,1%,15K	RN550-1502F	IRC	4701-03-1502	4
R238 R241	RES,MF,1/4W,1%,15	RN550F-15R0F	IRC	4701-03-1500	2
R100 R105	RES,MF,1/4W,1%,1.62K	RN550-[illegible]	IRC	4701-03-1621	2
R206 R226 R264	RES,MF,1/4W,1%,1.78K	RN550-1781F	IRC	4701-03-1781	3
R250 R263	RES,MF,1/4W,1%,18.2K	RN550-1822F	IRC	4701-03-1822	2
R114	RES,MF,1/4W,1%,200	RN550-[illegible]	IRC	4701-03-2000	
R251	RES,MF,1/4W,1%,21.5K	RN550-2152F	IRC	4701-03-2152	1
R105 R109 R154 R227 R88 R95	RES,MF,1/4W,1%,21.5	RN550-21R5F	IRC	4701-03-2159	4
R168 R170 R184 R212 R213 R270 R284	RES,MF,1/4W,1%,2.21K	RN550-[illegible]	IRC	[illegible]	[illegible]
R259 R284 R71	RES,MF,1/4W,1%,221K	RN550-2213F	IRC	4701-03-2213	4
R121 R148 R153 R21	RES,MF,1/4W,1%,2.37K	RN550-2371F	IRC	4701-03-2371	4
R116 R120 R122 R124 R210	RES,MF,1/4W,1%,240	RN550-24R0F	IRC	4701-03-2400	5
R112 R131 R240 R271 R58	RES,MF,1/4W,1%,2.49K	RN550-2491F	IRC	4701-03-2491	4
R144	RES,MF,1/4W,1%,270	RN550-27R0F	IRC	4701-03-2700	[illegible]

WAVETEK PARTS LIST — TITLE MAIN — ASSEMBLY NO 1100-00-0056 — PAGE: 6 — REV

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1 .XX ±.030		
	DO NOT SCALE DWG		
	SCALE		MODEL NO 146 — DWG NO 1100-00-0056 — REV G
			CODE IDENT 23338 — SHEET 1 OF 2

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MATION AND DESIGN RIGHTS BELONGING TO
WAVETEK AND MAY NOT BE REPRODUCED FOR ANY
REASON EXCEPT CALIBRATION OPERATION, AND
MAINTENANCE WITHOUT WRITTEN AUTHORIZATION

REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
R204	RES,MF,1/8W,1%,5.01K	RN55D-5011F	[illegible]	0701-03-5011	1
R219	[illegible]	RN55D-5112F	[illegible]	0701-04-5112	[illegible]
R100 R101 R171 R225 R232 R56 R57 R61 R62	RES,MF,1/8W,1%,51K	[illegible]	[illegible]	0701-03-5100	5
R216	RES,MF,1/8W,1%,5.32K	RN55D-5321F	[illegible]	0701-03-5321	[illegible]
R157 R180 R187 R194 R197	RES,MF,1/8W,1%,[illegible]	RN55D-1540F	[illegible]	0701-13-1540	[illegible]
R07 R08	[illegible]	RN55D-3651F	[illegible]	0701-13-3651	[illegible]
R255 R292 R42	RES,MF,1/8W,1%,5.61K	RN55D-5611F	[illegible]	0701-13-5611	3
R85	RES,MF,1/8W,1%,5.62K	[illegible]	[illegible]	0701-03-5621	[illegible]
R165	RES,MF,1/8W,1%,[illegible]	[illegible]	[illegible]	0701-03-6020	[illegible]
R256	RES,MF,1/8W,1%,6.02K	RN55D-6021F	[illegible]	[illegible]	[illegible]
R124 R259	RES,MF,1/8W,1%,6.52K	[illegible]	[illegible]	0701-03-6521	[illegible]
R151 R190 R199 R202 R203 R253	RES,MF,1/8W,1%,6.8K	[illegible]	[illegible]	0701-03-6840	[illegible]
R190	RES,MF,1/8W,1%,6.81K	RN55D-6841F	[illegible]	0701-03-6841	1
R180 R52 R8 R36	RES,MF,1/8W,1%,8.06	RN55D-8060F	[illegible]	0701-03-8060	[illegible]
R139 R20 R250 R271 R80 R30	RES,MF,1/8W,1%,8.75K	RN55D-8751F	[illegible]	0701-03-8751	6

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 7 | REV [illegible]

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
R01	[illegible]	[illegible]	[illegible]	0701-14-1004	1
R102 R81	RES,MF,1/8W,1%,1.91K	[illegible]	[illegible]	0701-13-1911	[illegible]
R150 R161 R167 R168	RES,MF,1/8W,1%,152	RN60F-1520F	[illegible]	0701-13-1520	4
R17 R59	[illegible]	[illegible]	[illegible]	0701-13-4641	[illegible]
R185 R186 R234 R235 R236 R242 R243 R244 R245 R246 R247 R248	[illegible]	[illegible]	[illegible]	0701-13-4990	12
R12 R15 R51 R65 R66 R68	RES,SET,2-1K,1/8W QTY(2)0701-03-1001	102-501-09	[illegible]	0790-00-0009	5
R24 R25	RES,MF,MIRED SET	102-501-50	[illegible]	0790-00-0045	1
	RES,MF,1/8W,1%,1K PART OF 0790-00-0055 QTY(2)				
R26 R27	RES,MF,1/8W,1%,10K PART OF 0790-00-0055 QTY(2)				
R28 R29	RES,MF,1/8W,1%,100K PART OF 0790-00-0055 QTY(2)				
R30 R31	RES,MF,1/8W,1%,1M PART OF 0790-00-0055 QTY(2)				
CR2 CR27 CR28 CR39	DIODE,ZENER 6.2V	1N4733	[illegible]	3001-01-0623	6

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 9 | REV [illegible]

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
Q28 Q4 Q47	TRANS	2N5640	[illegible]	0901-03-4420	3
Q11 Q26 Q30 Q44 Q52 Q43 Q54 Q57 Q6	TRANS	2N3646	[illegible]	[illegible]	10
Q39	TRANS	2N4067	[illegible]	0901-04-0470	1
Q46	TRANS	[illegible]	[illegible]	0901-06-2040	1
Q12 Q15 Q17 Q21 Q22 Q25 Q27 Q31 Q9	TRANS	2N5139	[illegible]	0901-05-1390	4
J50	TRANS	[illegible]	[illegible]	0901-05-1600	1
Q1 Q14	TRANS	[illegible]	[illegible]	0901-05-4000	2
Q16 Q18 Q19 Q20 Q32 Q33 Q38	TRANS	MPS-L60	[illegible]	[illegible]	7
Q45	TRANS	TIP-29	[illegible]	0902-00-0200	1
Q5 Q48	TRANS	[illegible]	[illegible]	0902-00-1040	2
Q22 Q23	TRANS,M/PR,2N5245 QTY(2)0901-03-4520	102-501-52	[illegible]	[illegible]	1
Q13 Q2	TRANS,SEL,2N5462 QTY(2)0901-03-4520	102-501-54	[illegible]	[illegible]	2
Q6 Q7	TRANS,M/PR,2N5245 QTY(2)0901-03-4520	102-501-53	[illegible]	0904-00-0004	1
Q49 Q50	TRANS,M/PR,2N5640	130-501-11	[illegible]	0904-00-0013	1

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 11 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
R276	[illegible]	[illegible]	[illegible]	0701-03-4752	1
R119 R180 R262	RES,MF,1/8,1%,400	[illegible]	[illegible]	0701-03-4990	[illegible]
R211 R56 R62 R68 R69 R69	RES,MF,1/8W,1%,0.909	[illegible]	[illegible]	0701-03-9091	[illegible]
R118 R125 R138 R145	RES,MF,1/8W,1%,511	RN55D-5110F	[illegible]	0701-03-5110	4
R189 R150 R152	RES,MF,1/8W,1%,56.2	RN55D-5620F	[illegible]	0701-03-5620	[illegible]
R287	RES,MF,1/8W,1%,57.6K	RN55D-5761F	[illegible]	0701-03-5761	1
R103 [illegible]	[illegible]	[illegible]	[illegible]	0701-04-6191	[illegible]
R76	RES,MF,1/8W,1%,681	RN55D-6810F	[illegible]	[illegible]	[illegible]
R218 [illegible]	[illegible]	RN55D-6981F	[illegible]	0701-03-6981	2
R46	RES,MF,1/8W,1%,750	[illegible]	[illegible]	0701-04-7500	1
R200 R60 R65	RES,MF,1/8W,1%,7.5K	[illegible]	[illegible]	0701-03-7501	3
R14	[illegible]	RN55D-7872F	[illegible]	0701-03-7872	1
R102 R21 R269 R270 R271 R277	RES,MF,1/8W,1%,825	RN55D-8250F	[illegible]	0701-03-8250	6
R162 R168 R172 R175	[illegible]	RN55D-8251F	[illegible]	0701-03-8251	4
R152 R75	RES,MF,1/8W,1%,82.5	[illegible]	[illegible]	0701-03-8250	2
R115 R127	RES,MF,1/8W,1%,90.9	RN55D-9090F	[illegible]	0701-03-9090	2

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 8 | REV [illegible]

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
CR4 CR9					
CR33 CR34	DIODE	SCR-1	SERT	4001-02-0001	2
CR14 CR16	DIODE	1N5716	GE	4002-01-5716	2
CR21 CR22 CR23 CR24 CR45 CR46	DIODE	FD-777	FAIR	4007-02-0777	6
CR1 CR15 CR17 CR18 CR19 CR20 CR25 CR26 CR29 CR3 CR30 CR31 CR32 CR35 CR36 CR37 CR38 CR40 CR41 CR42 CR43 CR44 CR5 CR6 CR7 CR8	DIODE	FD-6666	FAIR	4007-02-0666	26
CR10 CR11 CR12 CR13	DIODE,SEL,2-FD-777 QTY(4)4007-02-0777	102-501-57	[illegible]	4004-00-0002	1
CR47 CR48	DIODE,SEL,2-FD-777 QTY(2)4007-02-0777	102-501-58	[illegible]	[illegible]	1
Q3A	TRANS	2N2218A	[illegible]	0901-02-2191	1
Q55 Q56	TRANS	2N3694	[illegible]	0901-02-3691	2
Q37	TRANS	2N2905A	[illegible]	0901-02-9051	1
Q10 Q35	TRANS	2N3053	FAIR	0901-03-5030	2
Q29 Q5 Q51 Q52 Q59 Q60	TRANS	2N3906	FAIR	0901-03-6381	6
Q36	TRANS	2N3440	FAIR	0901-03-4400	1

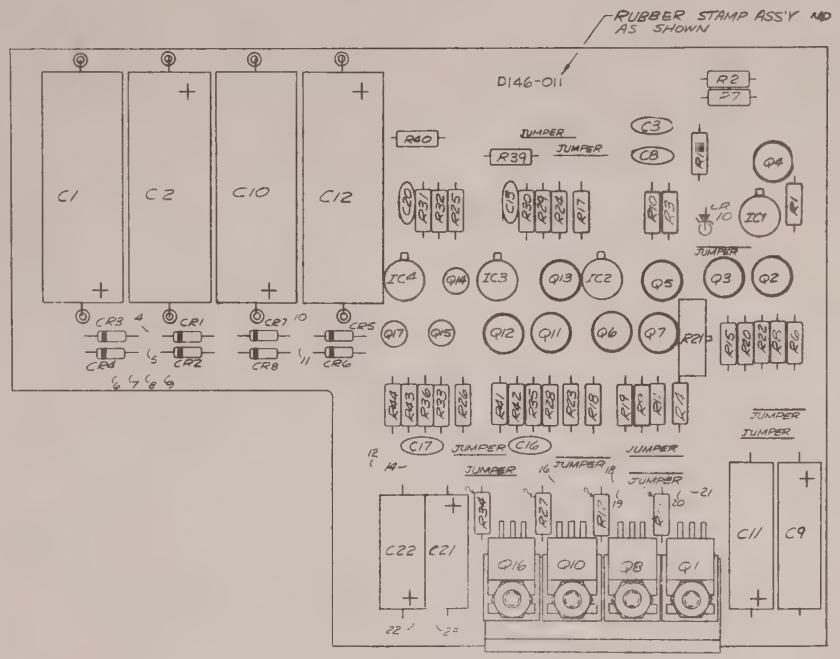
WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 10 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
Q01 Q42	TRANS,M/PR,2N5684 QTY(2)0901-03-4520	130-501-11	[illegible]	0904-00-0014	1
IC12	IC	LM 301AN	NSC	7000-03-0100	1
IC13	IC	MC10451	MOT	7000-10-4500	1
IC16	IC	CA-1024	RCA	7000-50-2800	1
IC19	IC	CA-1009	RCA	7000-50-4900	1
IC18	IC,CLASS 1,CA-3030 QTY(1)7000-50-3000	130-501-15	[illegible]	7200-00-0001	1
IC1 IC11 IC15 IC2 IC3 IC4 IC5 IC6 IC7 IC8 IC9	IC,CLASS 1,MC-704 QTY(1)7000-07-0000	130-501-11	[illegible]	7200-00-0006	11

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO 1100-00-0056 | PAGE: 12 | REV [illegible]

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 XX ±.030 ANGLES ±1		
	DO NOT SCALE DWG		MODEL NO 146 · DWG NO 1100-00-0056 · REV G
	SCALE		CODE IDENT 23338 · SHEET 2 OF 2



NOTES UNLESS OTHERWISE SPECIFIED
1. NUMBER INDICATE WIRE TERMINATION POINTS.

tolerance unless otherwise specified	rev	ecn	by	date	app.
XXX ± .010 XX ± .030	WAVETEK san diego, calif				
scale TWICE	by SCAY	date		app.	
material N/A	title ASSEMBLY POWER SUPPLY				
finish N/A	model no	dwg no		rev	

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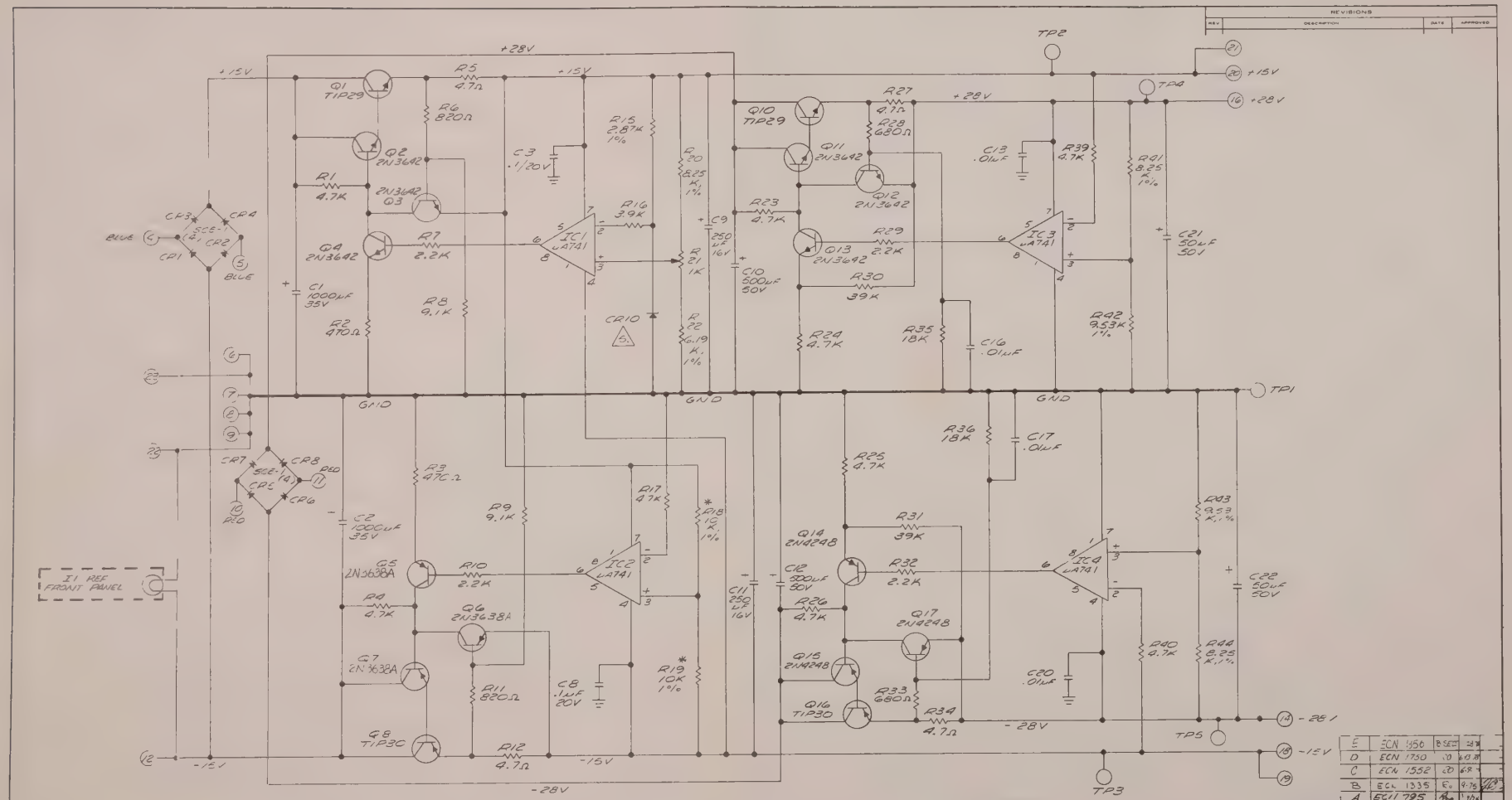

REV	ECN	BY	DATE	APP
E	ECN 1950	B.S.C.	2-8-78	
D	ECN 1750	[illegible]	[illegible]	
C	ECN 1552	[illegible]	[illegible]	
B	ECN 1335	[illegible]	9-76	
A	ECN 795	[illegible]	[illegible]	

TOLERANCE UNLESS OTHERWISE SPEC
XXX : .010
XX : .030
ANGLES : ±30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE N/A | BY GRAV | DATE 2-15-78 | APP [illegible]

MATERIAL N/A

TITLE SCHEMATIC, POWER SUPPLY

FINISH N/A

MODEL NO 146 | DWG NO 0103-00-0057 | REV E

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NOTES: UNLESS OTHERWISE SPECIFIED

1. * INDICATES MATCHED PAIR (R18 & R19)
2. RESISTORS ARE CARBON, 1/2W, 10%
3. DIODES ARE FD6666
4. CIRCLED NUMBERS, I.E. (1) ETC ARE WIRING INTERCONNECTION POINTS
5. ZENER DIODES ARE SELECTED PER WAVETEK SPEC. 130-506 (CR10)

REF DES. NOT USED
C4, C5, C6, C7, C14, C15, C18, C19
R13, R14, R37, R38
CR9, CR11, CR12, CR13

LAST REF DESIG
R44 IC4
C22 Q17
CR13

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NO.	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DWG,POWER	0100-00-0057	WVTK	0100-00-0057	1
NONE	SCHEMATIC,POWER	0105-00-0057	WVTK	0105-00-0057	1
NONE	HEAT SINK	102-[illegible]	WVTK	1000-00-2084	1
NONE	INSULATOR,MICA	102-[illegible]	WVTK	1000-00-2080	4
C15 C16 C17 C20	CAP,CERM,[illegible]	CK[illegible]	[illegible]	1500-01-0110	4
C5 C6	CAP,CERM,.1MF,20V	[illegible]	[illegible]	1500-01-0014	2
C1 C2	CAP,ELECT,1000MF,35V	[illegible]	[illegible]	1500-31-0212	2
C11 C9	CAP,ELECT,2500MF,16V	5000257G016BF7	SPRAGUE	1500-32-5101	2
C21 C22	CAP,ELECT,500MF,50V	5D015A06G050D07	SPRAGUE	1500-35-0005	2
C10 C12	CAP,ELECT,500MF,50V	30D507G050GL4	SPRAGUE	1500-35-0103	2
NONE	POWER	100-111	[illegible]	1700-00-0054	1
NONE	TWASIPAD	10125A	[illegible]	6800-11-0005	9
R21	POT,1KW,1K	91[illegible]	[illegible]	4050-01-0209	1
R12 R27 R30 R5	RES,C,1/2W,5%,0.7	RC20GF-0R7	STAPL	4700-25-0079	4
R35 R36	RES,MF,1/5W,1%,1M,2P	RN550-1M22F	TRW	4701-03-1M22	2
R10 R29 R32 R7	RES,MF,1/8W,1%,2.21K	RN550-[illegible]	TRW	4701-03-2211	4
R15	RES,MF,1/8W,1%,2.87K	RN550-[illegible]	TRW	4701-03-2871	1
R30 R31	RES,MF,1/8W,1%,3K	RN550-[illegible]	TRW	4701-03-3032	2

WAVETEK PARTS LIST — TITLE POWER — ASSEMBLY NO 1100-00-0057 — PAGE: 1 — REV H

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NO.	MFGR	WAVETEK NO.	QTY/PT
Q16 Q4	TRANS	[illegible]	[illegible]	4902-00-0400	[illegible]
IC1 IC2 IC3 IC4	IC	[illegible]	[illegible]	7000-07-0101	4

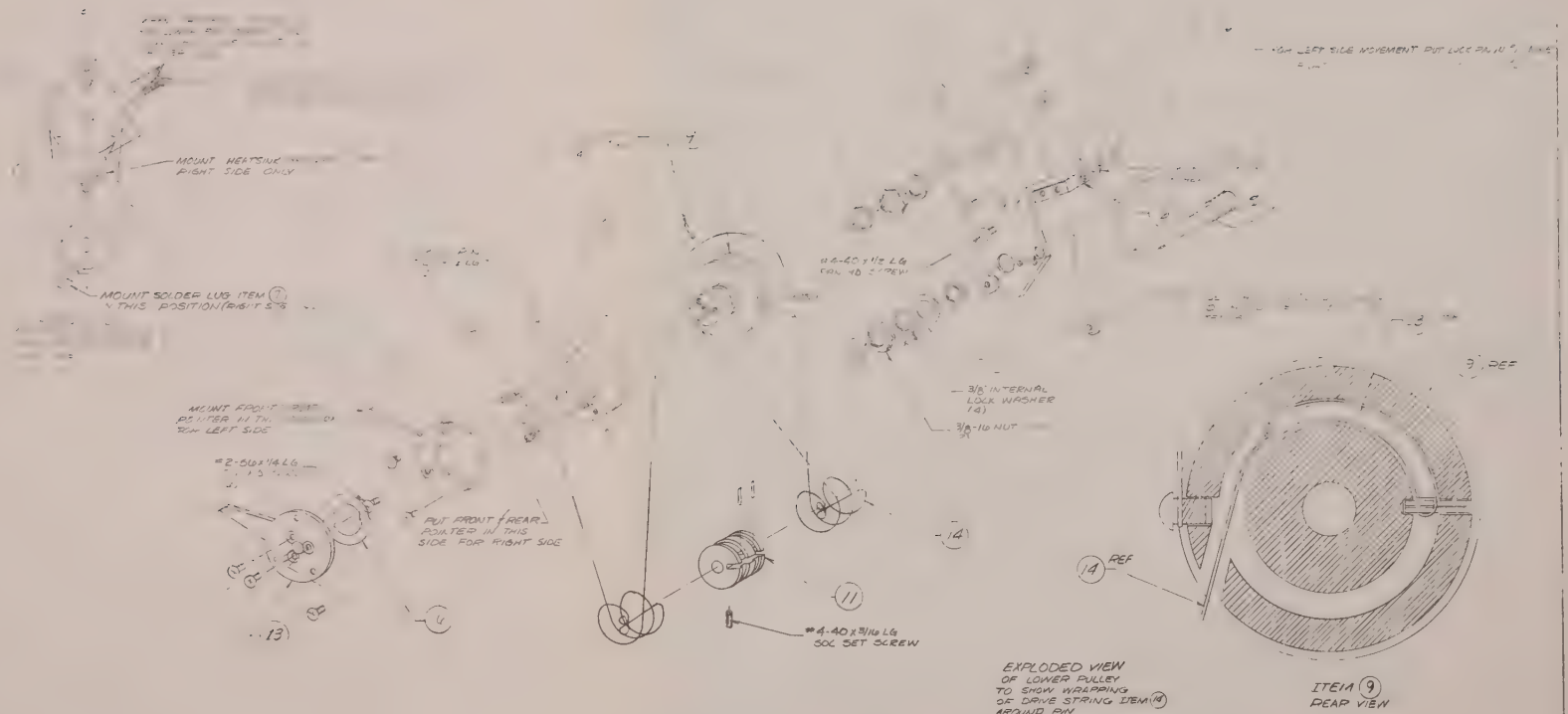
WAVETEK PARTS LIST — TITLE POWER — ASSEMBLY NO 1100-00-0057 — PAGE: 3 — REV H

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NO.	MFGR	WAVETEK NO.	QTY/PT
R1A	RES,MF,1/8W,1%,3.92K	RN550-3921F	TRW	4701-03-3921	1
R2 R3	RES,MF,1/8W,1%,460Ω	RN550-[illegible]	TRW	4701-03-4600	2
R1 R17 R25 R28 R25 R26 R39 R6 R40	RES,MF,1/8W,1%,4.75K	RN550-4751F	TRW	4701-03-4751	9
R22	RES,MF,1/8W,1%,6.19K	RN550-6191F	TRW	4701-03-6191	1
R28 R33	RES,MF,1/8W,1%,8K1	RN550-[illegible]	TRW	4701-03-8810	2
R11 R6	RES,MF,1/8W,1%,825	RN550-[illegible]	TRW	4701-03-8250	2
R20 R21 R40	RES,MF,1/8W,1%,8.25K	RN550-[illegible]	TRW	4701-03-8251	3
R8 R9	RES,MF,1/8W,1%,9.09K	RN550-9091F	TRW	4701-03-9091	2
R22 R23	RES,MF,1/8W,1%,9.53K	RN550-9531F	TRW	4701-03-9531	2
R1A R19	RES,BT,2-10K,1/8W GEY12:W701-03-1002	102-5001-A8	WVTK	4799-00-0018	1
CR10	DIODE	1N5341	MICRO	4901-01-4581	1
CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8	DIODE	SCF-1	SCWI	4901-02-0001	8
Q5 Q6 Q7	TRANS	2N6384	FAIRCH	4901-03-6381	3
Q11 Q12 Q13 Q2 Q3 Q4	TRANS	2N3642	FAIRC	4901-03-6020	6
Q14 Q15 Q17	TRANS	2N6284	FAIRC	4901-06-2880	3
Q1 Q10	TRANS	TIP-29	[illegible]	4902-00-0290	2

WAVETEK PARTS LIST — TITLE POWER — ASSEMBLY NO 1100-00-0057 — PAGE: 2 — REV H

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROTENDR		TITLE POWER SUPPLY
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1 XX ±.030		
	DO NOT SCALE DWG		MODEL NO 146 — DWG NO 1100-00-0057 — REV H
	SCALE		CODE IDENT 23338 — SHEET 1 OF 1



REV	ECN	BY	DATE	APP
D	ECN 1704			
C	ECN 1376			
B	ECN 1143			
A	ECN 462			

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0.30

WAVETEK SAN DIEGO CALIFORNIA

SCALE

BY Goukkin DATE 3-17-72 APP

MATERIAL

FINISH

TITLE ASSEMBLY MOVEMENT

MODEL NO 40 DWG NO 0 038-00-0329 REV D

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGN-PART-NO	MFGR	WAVETEK NO.	QTY/NT
NONE	ASSY DRAW, LEFT MOVE	0102-00-0329	WVTK	0102-00-0329	1
11	PULLEY,LOWER	146-315	WVTK	1400-00-2520	1
8	PLATE,BEARING	146-317	WVTK	1400-00-2533	1
13	POINTER,FRONT FROM:1400-00-2546	146-333	WVTK	1400-00-2609	1
12	POINTER,REAR FROM:1400-00-2540	146-334	WVTK	1400-00-2619	1
19	PULLEY,FT	146-353	WVTK	1400-00-2620	1
7	PULLEY,REAR	146-354	WVTK	1400-00-2630	1
16	WASHER,SPRING MCF13200-07-0001	146-356	WVTK	1400-00-2649	1
14	DRIVE TIMING	146-335	WVTK	1400-00-9050	1
21	SOLDER LUG	1497	SMITH	2100-04-0012	1
NONE	INSERT # 4	74-11-104-13	SUTCO	2800-04-0016	1
22	WASHER,SHOULDER	2660	SMITH	2800-26-0001	8
28	SPRING	E1-0108-8	LEE	2800-31-0001	2
1	POT,DIAL,5K	146-501	WVTK	4600-05-0203	1
2	POT,DIAL,5K	146-502	WVTK	4600-05-0206	1

WAVETEK PARTS LIST	TITLE LEFT MOVEMENT	ASSEMBLY NO. 1101-00-0070 PAGE: 1	REV E

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJENGR		TITLE LEFT MOVEMENT
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 .XX ± .030 ANGLES ± 1°		
	DO NOT SCALE DWG	MODEL NO 146	DWG NO 146-002 1101-00-0070 REV
	SCALE	CODE IDENT 23338	SHEET 1 OF 1

REV		BY			APV
F					

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REFERENCE DESIGNATIONS	PART DESCRIPTION	DWG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
NONE	ASSY DWG, LEFT MOVE	0102-00-0329	WVTK	0102-00-0329	1
11	PULLET,LUMEN	146-315	WVTK	1400-00-2520	1
8	PLATE,BEARING	146-317	WVTK	1400-00-2533	1
6	BRAT,HEATSINK	146-338	WVTK	1400-00-2563	1
7	LUG,SOLDER USE 2100-04-0012	146-343	WVTK	1400-00-2579	1
13	POINTER,FRONT FROM:1400-00-2590	146-333	WVTK	1400-00-2609	1
12	POINTER,REAR FROM:1400-00-2590	146-334	WVTK	1400-00-2619	1
10	PULLET,FI	146-353	WVTK	1400-00-2620	1
9	PULLET,REAR	146-354	WVTK	1400-00-2630	1
16	WASHER,SPRING REF:3200-07-0001	146-356	WVTK	1400-00-2649	1
14	DRIVE STRING	146-335	WVTK	1400-00-4050	1
21	SOLDER LUG	1497	SMITH	2100-04-0012	1
NONE	INSERT # 8	74-11-104-16	SUTCO	2800-09-0016	1
22	WASHER,SHOULDER	2080	SMITH	2800-26-0001	6
20	SPRING	21-0108-8	LEE	2800-31-0001	2
1	POT,DIAL,5K	146-501	WVTK	4000-05-0203	1

WAVETEK PARTS LIST	TITLE RIGHT MOVEMENT	ASSEMBLY NO. 1101-00-0091 PAGE: 1	REV F

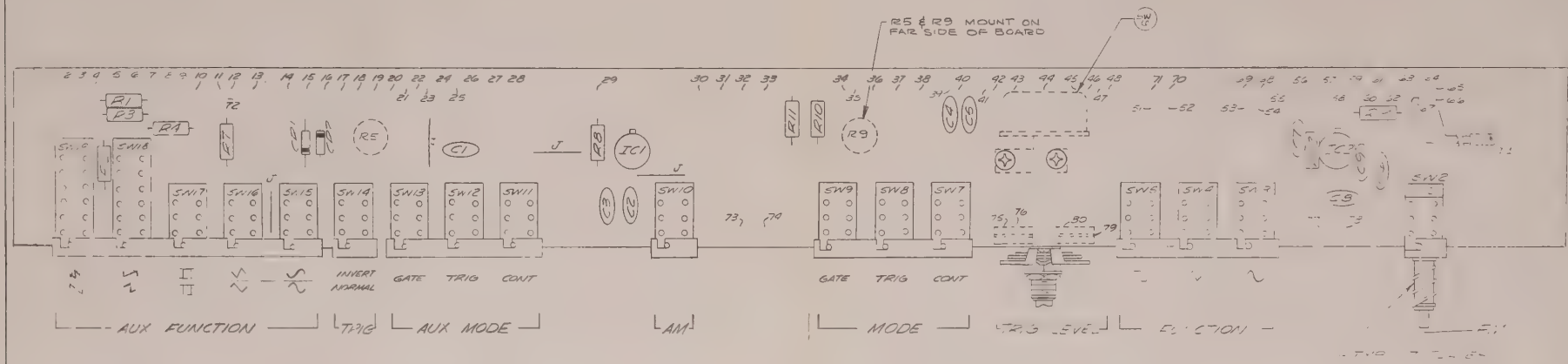
REFERENCE DESIGNATIONS	PART DESCRIPTION	DWG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PI
2	POT,DIAL,5K	146-502	WVTK	4000-05-0204	1

WAVETEK PARTS LIST	TITLE RIGHT MOVEMENT	ASSEMBLY NO. 1101-00-0091 PAGE: 2	REV F

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE RIGHT MOVEMENT
	RELEASE APPROV		
FIN SM WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG	MODEL NO. 146	DWG NO. 146-099 / 1101-00-0091 — REV F
	SCALE	CODE IDENT 23338	SHEET 1 OF 1

NOTE UNLESS OTHERWISE SPECIFIED

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



REV	ECN	BY	DATE	APP
F	ECN 1764	CH	2/8	
E	ECN 1524	RC	2/8	
D	ECN 1335	RC	8-1-72	
C	1146	DG	11-6-70	
B	ECN 949	BA		
A	ECN 878	BA	2-14-69	

TOLERANCE UNLESS OTHERWISE SPEC
.XXX ± .010
.XX ± .030
ANGLES ± 0°30'

SCALE 2/1

MATERIAL

FINISH

WAVETEK SAN DIEGO CALIFORNIA

BY B. REDMAN DATE 2/14/73 APP

TITLE
SWITCH BOARD

DWG. NO. 146 DWG. NO. 0101-00-0038 REV. F

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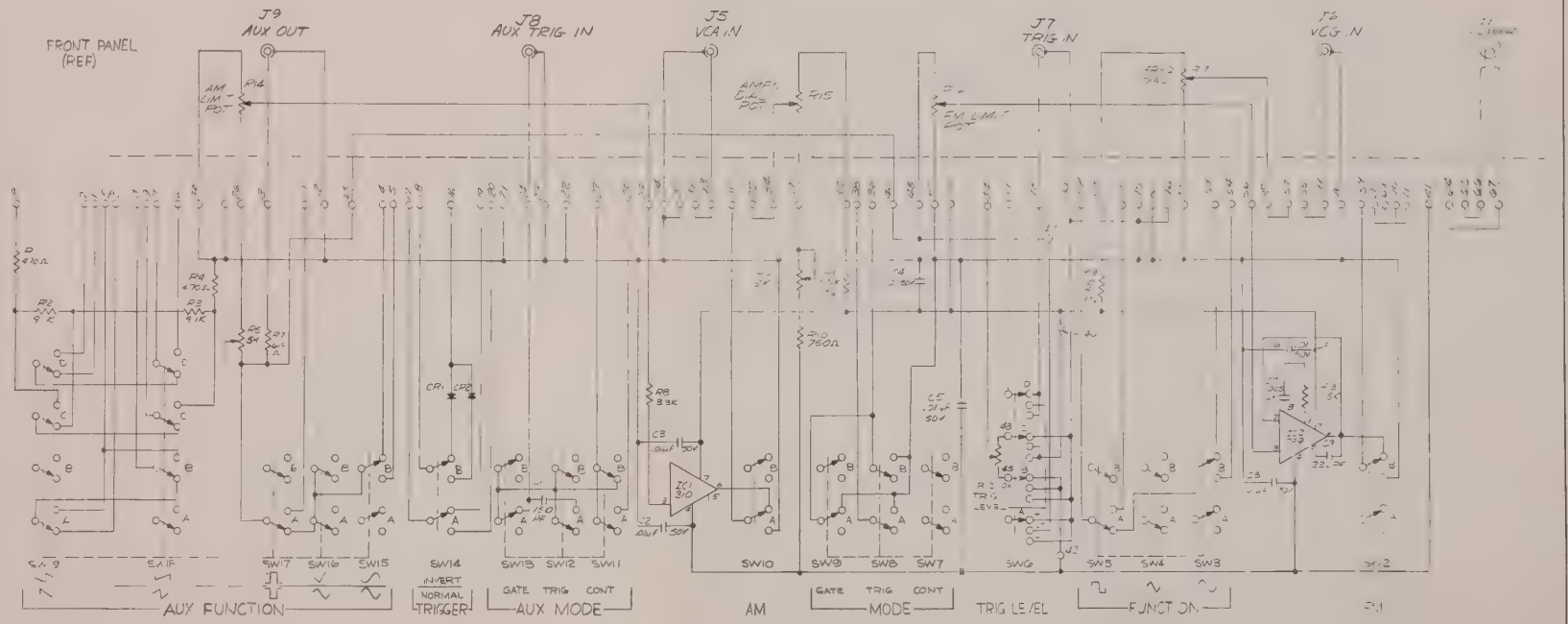
[illegible] LAMPS ON PUSH SWITCHES SHOULD BE PANNED BEFORE MOUNTING TO FRONT PANEL

NOTES: UNLESS OTHERWISE SPECIFIED



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

1. NUMBERS ARE FOR INTERCONNECTION PURPOSES ONLY, SEE 0004-00-0037

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ECN	BY	DATE	APP
B	146		6-5-73	
A	ECN 878		3-8-73	

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO, CALIFORNIA

SCALE N/A

BY B. FRIDMAN DATE 3/16/73 APP.

MATERIAL N/A

TITLE SCHEMATIC SWITCH BOARD

FINISH N/A

MODEL NO 146 DWG NO 0003-00-0058 REV B

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	MANUFACTURER-PART-NO	[illegible]	WAVETEK NO.	[illegible]
NONE	ASST OVRG, SWITCH	0101-00-0038	[illegible]	0101-00-0038	.
NONE	SCREWPATIL, SWITCH	0103-00-0038	[illegible]	0103-00-0038	.
GND	TWIN SW ASST	1W0-0U5	[illegible]	1U02-00-0015	.
C2 C3 C4 C5 C6 C8	CAP,CER,.01MF,50V	CK-103	[illegible]	1500-01-0310	9
C1	CAP,CER,150PF,,5V	CC-151	[illegible]	1500-01-5111	.
C4	CAP,CER,220PF,,1KV	CC-221	[illegible]	1500-02-2111	.
C7	CAP,CER,.005MF,50V	CK-502	[illegible]	1500-05-0210	1
NONE	SWITCH	1W0-132	[illegible]	1700-00-0038	.
J1	CAPP	[illegible]	[illegible]	2W00-02-0013	1
J3	FANNING STRIP	FS1306	[illegible]	2B00-00-0020	2
[illegible]	PUT,TRIM,SQ	91AW5P	[illegible]	W000-05-0205	2
R14	RES,MF,1/8W,1%,100	MF5506-100RF	[illegible]	4701-03-1001	.
R11	[illegible]	[illegible]	[illegible]	4701-03-1211	.
R13	[illegible]	[illegible]	[illegible]	4701-03-1301	1
R2	RES,MF,1/8W,1%,3.32K	[illegible]	[illegible]	4701-03-3321	.
[illegible]	RES,MF,1/8W,1%,40K	[illegible]	[illegible]	4701-03-4002	2
R1	RES,MF,1/8W,1%,619	MF5506-6190F	[illegible]	4701-03-6190	.
R10	[illegible]	[illegible]	[illegible]	4701-03-7500	.

WAVETEK PARTS LIST

TITLE [illegible]

ASSEMBLY NO [illegible]

REV

PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	[illegible]	[illegible]	[illegible]	[illegible]
R2 R3	RES,MF,1/8W,1%,2.49K	[illegible]	[illegible]	4701-03-2491	.
CR1 CR2	DIODE	FD-0001	[illegible]	[illegible]	2
DR10 DR12 DR13	[illegible]	1N4148	[illegible]	5102-00-0003	
DR11 DR12 DR13	[illegible]	1S2-001	[illegible]	5103-00-2103	.
NONE	[illegible]	1W0-001	[illegible]	5103-00-0000	
NONE	SWITCH	J-5B2365-BLBLB	[illegible]	5103-00-0003	.
LG1	IC	7000-03-1000	[illegible]	7600-03-1000	.
LG2	LG,CLL455 1,MM-704 UT:11:7000-03-0000	1SU-501-13	[illegible]	7000-00-0005	.

WAVETEK PARTS LIST

TITLE [illegible]

ASSEMBLY NO 1100-00-0058

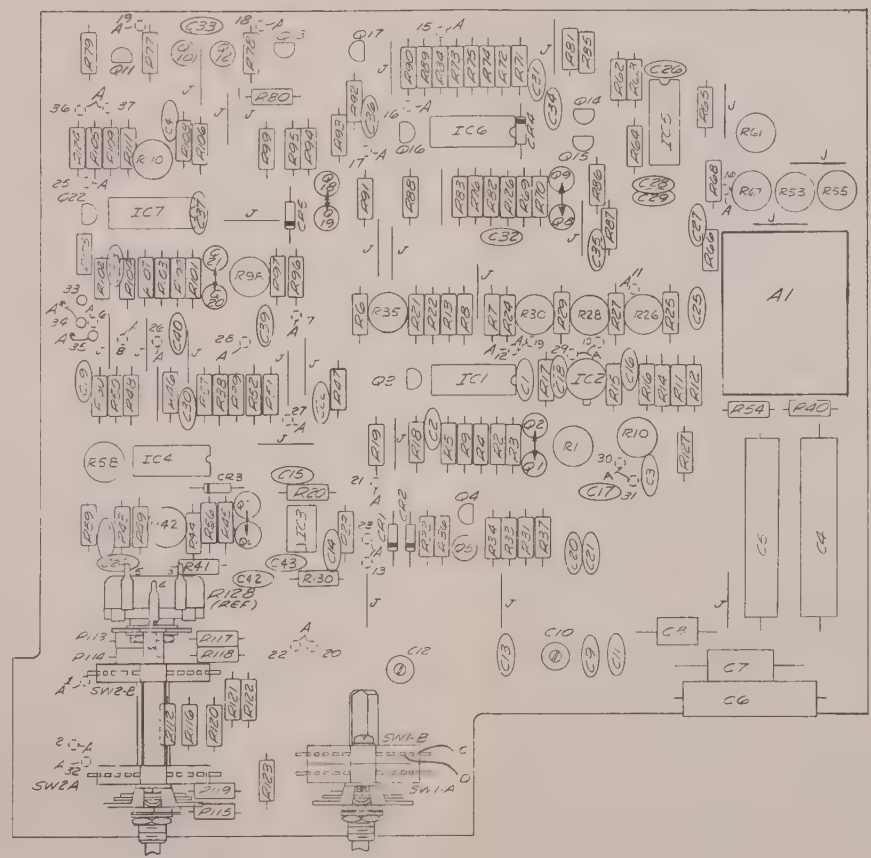
REV

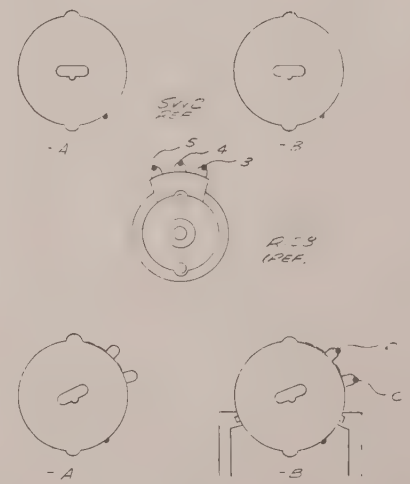
PAGE: 2

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	ENG. ENGR		TITLE SWITCH
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX .010 ANGLES ±1 .XX .030		
	DO NOT SCALE DWG	MODEL NO 146	DRAWING 146-032 1100-00-0058 REV. E
	SCALE	DWG. SIZE 23338	SHEET OF

NOTE UNLESS OTHERWISE SPECIFIED

REVISIONS				
REV	DESCRIPTION		DATE	APPROVED
A	ECN 876			
B	ECN 943			
C	ODC ECN 1335	ADDED SHEET 3 P/N	8-7-74	





1 A*- INDICATES AMP PINS MOUNTED ON COMPONENT SIDE

NOTES: UNLESS OTHERWISE SPECIFIED:

TOLERANCE UNLESS OTHERWISE SPEC XXX ± .010 XX ± .030 ANGLES ± 0°30'	REV	ECN	BY / DATE / APP
	WAVETEK	SAN DIEGO, CALIFORNIA	
SCALE —	BY B. RODHAM	DATE 9/6/73	APPD
MATERIAL —	TITLE ASSY AUXILIARY BOARD		
FINISH —	MODEL NO 146	DWG NO. 0101-00-0059	SHEET 1 OF 3 REV C

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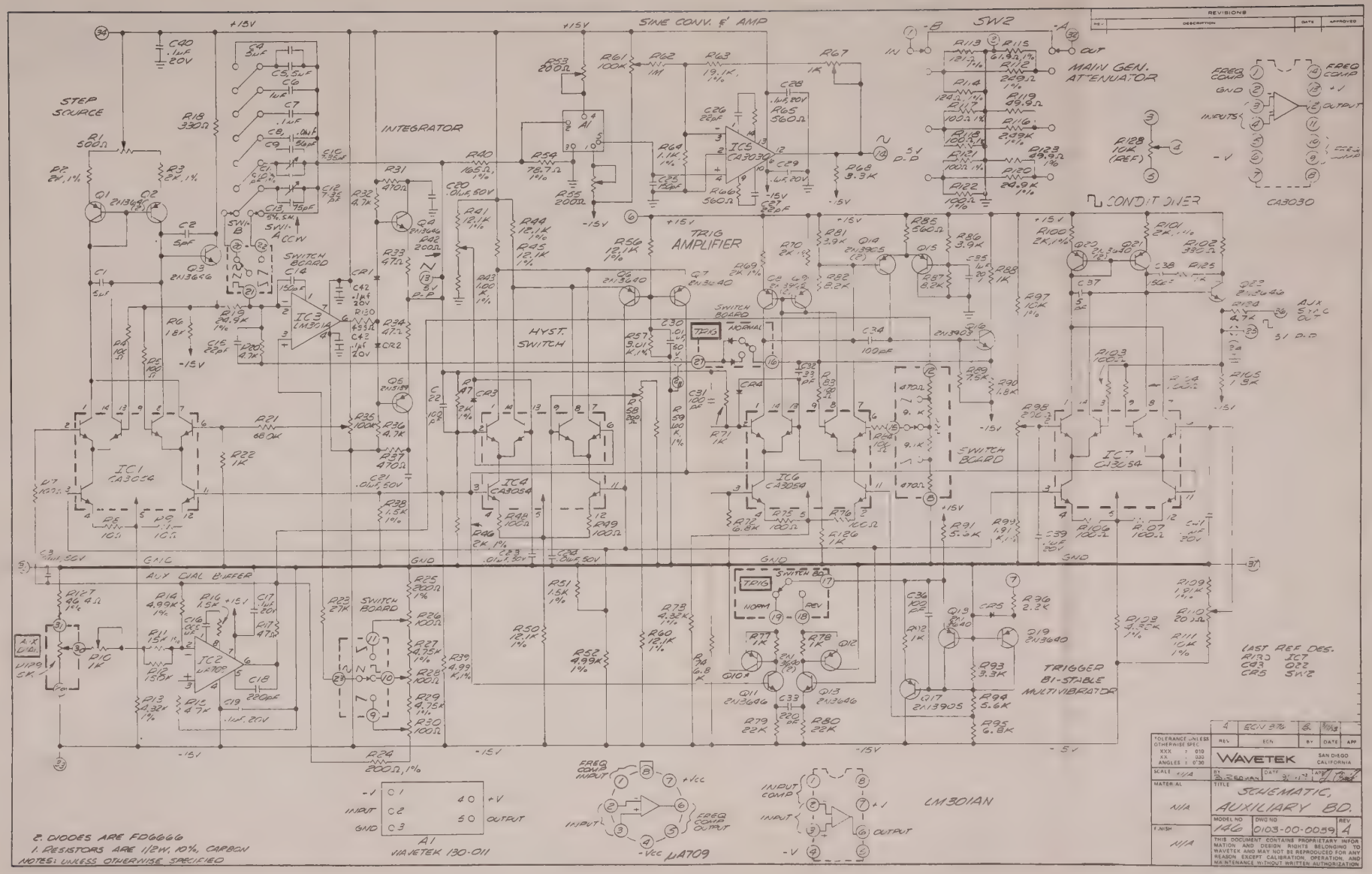
STEP SOURCE
INTEGRATOR
SINE CONV. & AMP
TRIG AMPLIFIER
HYST. SWITCH
SWITCH BOARD
MAIN GEN. ATTENUATOR
CONDIT DIVER
CA3030
AUX CIAL BUFFER
TRIGGER BI-STABLE MULTIVIBRATOR
LM301AN
μA709
A1 WAVETEK 130-011
2. DIODES ARE FD6666
1. RESISTORS ARE 1/2W, 10%, CARBON
NOTES: UNLESS OTHERWISE SPECIFIED
LAST REF DES. R130 IC7 C43 Q22 CR5 SW2
WAVETEK
SAN DIEGO CALIFORNIA
SCHEMATIC, AUXILIARY BD.
MODEL NO 146
DWG NO 0103-00-0039
REV A
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REASON EXCEPT CALIBRATION, OPERATION, AND
MAINTENANCE WITHOUT WRITTEN AUTHORIZATION

REV	EN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
[illegible]	ASSY DRWG, AUXILLARY	0101-00-0059	WVTK	0101-00-0059	.
[illegible]	SCHEMATIC, AUXILLARY	0103-00-0059	WVTK	0103-00-0059	1
A1	SLIDE MOD	130-021	WVTK	1200-00-0001	.
SM1	ATTCH DR ASSY	140-007	WVTK	1202-00-0017	.
SM2	FREW/PREMIUM DR ASSY	140-009	WVTK	1202-00-0019	.
C1 C2 C37	CAP,CER,5WF,1KV	00-050	CML	1500-00-5011	3
C22 C31 C34 [illegible]	CAP,CER,10WPF,1KV	00-101	CML	1500-01-0111	[illegible]
C24 C21 C23 [illegible] C30	CAP,CER,.01MF,50V	CK-103	CML	1500-01-0310	[illegible]
C17 C19 C28 [illegible] C34 C40 C41 [illegible]	CAP,CER,.1MF,20V	CK20-104	AMCE	1500-01-0413	[illegible]
C14 C25 C38	CAP,CER,15WPF,1KV	00-151	CML	1500-01-5111	3
C13 C26 C27	CAP,CER,22PF,1KV	00-220	CML	1500-02-2011	3
[illegible] C33	CAP,CER,33PF,1KV	00-330	CML	1500-03-3011	1
C32	CAP,CER,.003MF,50V	CK-502	CML	1500-03-0211	.
[illegible]	CAP,MICA,50PF,500V	CM15-5060	ARCO	1500-15-0000	1
[illegible]	CAP,MICA,75PF,500V	CM15-7500	ARCO	1500-17-5000	.
[illegible]	CAP,MICA,910PF,100V	CM15-9110	CM	1500-19-1101	.

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-00-0059 — REV [illegible] — PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
M71 M77 M76 M88 M92					
M111 M97	RES,MF,1/8W,1%,10K	MR55D-1002F	TWA	4701-03-1002	2
M8 M9	RES,MF,1/8W,1%,10	MR55D-[illegible]	[illegible]	4701-03-1009	[illegible]
M84	[illegible]	MR55D-1101F	[illegible]	[illegible]	1
M113	[illegible]	MR55D-1210F	[illegible]	4701-03-1210	.
M41 M44 M43 M39 M56 M40	[illegible]	MR55D-1212F	[illegible]	4701-03-1212	8
M[illegible]	RES,MF,1/8W,1%,12M	MR55D-1209F	[illegible]	4701-03-1209	.
M16 M38 M51	RES,MF,1/8W,1%,1.5K	MR55D-1501F	TWA	4701-03-1501	3
M11	RES,MF,1/8W,1%,15K	MR55D-1502F	MR	4701-03-1502	1
M12	RES,MF,1/8W,1%,15W	MR55D-1503F	[illegible]	4701-03-1503	1
M4	RES,MF,1/8W,1%,165	MR55D-1650F	TWA	4701-03-1650	1
M105 M6 M90	RES,MF,1/8W,1%,1.78K	MR55D-1781F	TWA	4701-03-1781	3
M63	RES,MF,1/8W,1%,19.1K	MR55D-1912F	TWA	4701-03-1912	1
M24 M25	RES,MF,1/8W,1%,200	MR55D-2000F	TWA	4701-03-2000	2
M100 M101 M2 M3 M46 M47 M89 M70	RES,MF,1/8W,1%,2K	MR55D-2001F	TWA	4701-03-2001	8
M79 M80	RES,MF,1/8W,1%,21.5K	MR55D-2152F	TWA	4701-03-2152	2
M49	RES,MF,1/8W,1%,2.21K	MR55D-2221F	TWA	4701-03-2211	1

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-00-0059 — REV [illegible] — PAGE: 3

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
M5	RES,MF,1/8W,1%,7.5K	MR55D-7501F	[illegible]	4701-03-7501	1
M39	RES,MF,1/8W,1%,8.7	[illegible]	TWA	4701-03-8709	1
M82 M87	RES,MF,1/8W,1%,8.25K	[illegible]	[illegible]	4701-03-8251	2
M82	RES,MF,1/8W,1%,10	MR60D-1000F	[illegible]	4701-13-1000	.
M104 M44	RES,MF,1/8W,1%,1.91K	MR60D-1911F	[illegible]	4701-13-1911	.
M102 M10	RES,MF,1/8W,1%,33Z	MR60D-3320F	[illegible]	4701-13-3320	2
M114 M123	RES,MF,1/8W,1%,49.9	[illegible]	TWA	4701-13-4999	2
M21	RES,MF,1/8W,1%,8.06K	[illegible]	TWA	4701-13-8063	1
LM1 LM2 LM3 LM4 LM5	JUMPER	JP-0000	[illegible]	4807-02-0000	5
U1 U19 U12 U18 U19 U2 U24 U21 U6 U7	TRANS	2N3640	[illegible]	4901-03-0400	10
U11 U13 U22 U3 U4	TRANS	2N3646	[illegible]	4901-03-0406	3
U10	TRANS	2N3903	[illegible]	4901-03-0430	1
U14 U15 U17 U8 U9	TRANS	2N3905	[illegible]	4901-03-0350	3
U5	TRANS	2N3159	[illegible]	4901-03-1390	1
IC3	IC	LM 3018N	[illegible]	7000-03-0100	1
IC1 IC4 IC6 IC7	IC	LM-3045N	MLE	7000-30-0400	.
IC5	IC,CLASS 1,CR-3030	130-301-15	[illegible]	7000-00-0001	4

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-00-0059 — REV [illegible] — PAGE: 5

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
[illegible]	CAP,POLYC,.01MF,100V	[illegible]	[illegible]	1500-01-0304	.
[illegible]	CAP,POLYC,.1MF,100V	[illegible]	[illegible]	1500-01-0404	.
[illegible]	CAP,POLYC,1MF,100V	210-01C-105F	[illegible]	1500-01-0504	.
C4 C5	[illegible]	C1A505F	[illegible]	1500-05-0504	2
C10 C12	CAP,1.7-55MF,250V	73-1X,RG-02 7/35 MF	[illegible]	1500-35-5000	2
[illegible]	AXR	140-133	[illegible]	1700-00-0139	.
[illegible]	CONN	0639-0	[illegible]	2100-03-0017	33
[illegible]	PIN,MALE	01-02-2	[illegible]	2100-03-0020	32
M20 M28 M30	POT,TRIM,100	V1X100	[illegible]	4800-01-0103	3
M10 M07	POT,TRIM,1K	V1X1K	[illegible]	4800-01-0209	2
M35 M81	POT,TRIM,100K	V1X100K	[illegible]	4800-01-0402	2
M110 M42 M53 M55 M58 M40	POT,TRIM,200	[illegible]	[illegible]	4800-02-0101	4
M1	POT,TRIM,500	V1X500	[illegible]	4800-03-0104	1
M103 M104 M108 M107 M111 M112 M121 M122 M4 M48 M49 M3 M7 M75 M76 M83 M84	RES,MF,1/8W,1%,100	MR55D-1000F	MR	4701-03-1000	[illegible]
M125 M126 M22 M23 M59	RES,MF,1/8W,1%,1K	MR55D-1001F	MR	4701-03-1001	[illegible]

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-00-0059 — REV [illegible] — PAGE: 2

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
M112	RES,MF,1/8W,1%,249	MR55D-2490F	MR	4701-03-2490	.
M110	RES,MF,1/8W,1%,2.49K	[illegible]	[illegible]	4701-03-2491	.
M120 M19	RES,MF,1/8W,1%,2.74K	MR55D-2742F	MR	4701-03-2742	.
M23	RES,MF,1/8W,1%,27.4K	MR55D-2742F	TWA	4701-03-2742	.
M37	RES,MF,1/8W,1%,3.01K	MR55D-3011F	MR	4701-03-3011	.
M88 M93	RES,MF,1/8W,1%,3.32K	MR55D-3321F	MR	4701-03-3321	2
M61 M88	RES,MF,1/8W,1%,3.92K	MR55D-3921F	TWA	4701-03-3921	2
M108 M13 M73	RES,MF,1/8W,1%,4.32K	[illegible]	[illegible]	4701-03-4321	3
M31 M37	RES,MF,1/8W,1%,400	MR55D-4000F	[illegible]	4701-03-4000	2
M127 M17 M33 M34	[illegible]	[illegible]	TWA	4701-03-4004	4
M124 M15 M20 M27 M29 M32 M36	[illegible]	[illegible]	TWA	4701-03-4751	7
M130	RES,MF,1/8,1%,499	MR55D-4990F	TWA	4701-03-4990	1
M14 M39 M32	[illegible]	[illegible]	TWA	4701-03-4991	3
M65 M66 M85	[illegible]	MR55D-5760F	TWA	4701-03-5760	3
M41 M46	RES,MF,1/8W,1%,5.76K	[illegible]	TWA	4701-03-5761	2
M115	[illegible]	MR55D-6194F	MR	4701-03-6194	.
M72 M74 M43	[illegible]	[illegible]	[illegible]	4701-03-6811	[illegible]

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-00-0059 — REV [illegible] — PAGE: 4

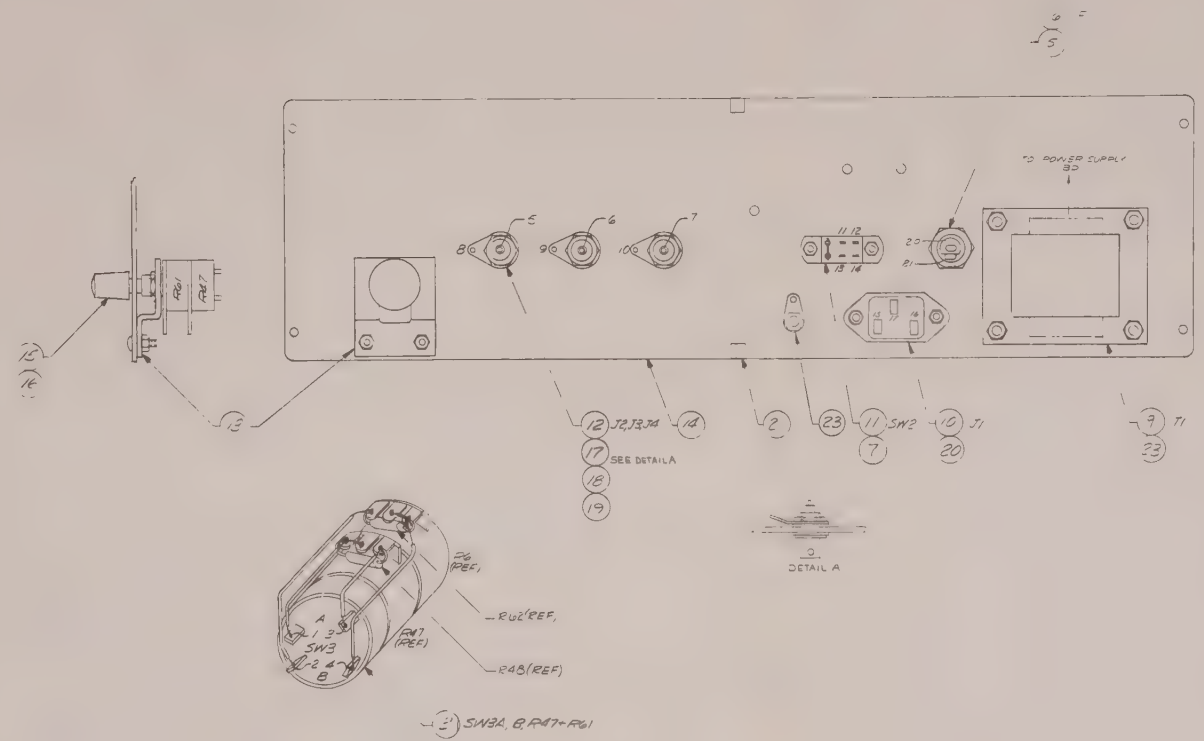
REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGN-PART-NO	MFGN	WAVETEK NO.	QTY/PI
	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	7200-00-0060	.

WAVETEK PARTS LIST — TITLE AUXILLARY — ASSEMBLY NO 1100-01-0059 — REV [illegible] — PAGE: 8

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	ENGINEER		TITLE AUXILLARY
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX .010 ANGLES ±1 .XX .030		
	DO NOT SCALE DWG		MODEL NO 146 — DWG NO 146-033 / 1100-00-0059 — REV C
	SCALE		CODE IDENT 23338 — SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED



G	ECN 1714	[illegible]	[illegible]	
F	ECN 1719	[illegible]	[illegible]	
E	ECN 1526	[illegible]	[illegible]	
D	ECN 1451	[illegible]	[illegible]	
C	ECN 970	[illegible]	[illegible]	
B	ECN 877	[illegible]	[illegible]	
A	[illegible]	[illegible]	[illegible]	

REV	ECN	BY	DATE	APP

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE N/A | BY [illegible] | DATE [illegible] | APP [illegible]

MATERIAL N/A

TITLE ASSY REAR PANEL

MODEL NO | DWG NO 0102-00-0330 | REV G

FINISH N/A

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY UNMW, REAR PNL	0102-00-0330	WVTK	0102-00-0330	1
4	TRANSFORMER	140-500	WVTK	1204-00-0006	1
15	BRKT,SW	140-326	WVTK	1400-00-2543	1
NONE	END BELL	157-500-E8	WVTK	1400-00-3224	1
14	PANEL,REAR	1400-00-8710	WVTK	1400-00-8710	1
NONE	LABEL,[illegible]	1400-06-8970	WVTK	1400-06-8970	1
12	BNC [illegible]	RC-7906	KING	2100-01-0002	3
10	RECEPT,FUSER	EAC-301	SMCFT	2100-03-0005	1
20	TERM,LUGS LUG	1414-4	SMITH	2100-04-0008	1
23	TERM,LUGS LUG	1414-8	SMITH	2100-04-0010	1
18	SOLDER LUG	1497	SMITH	2100-04-0012	3
NONE	SOLDER LUG	1405-6	SMITH	2100-04-0025	1
15	KNOB	020-352	ELMA	2400-01-0003	1
16	KNOB CAP	040-302	ELMA	2400-01-0004	1
6	FUSE,250V,1/2A,SB	313.500	LITFU	2400-03-0010	1
5	FUSE HOLD	345001	LITFU	2400-03-0012	1
21	FAST,CHASSIS	1591-C11	OSECU	2600-04-0022	2
17	WASHER,SHOULDER	2608	SMITH	2600-27-0004	3

WAVETEK PARTS LIST

TITLE
REAR PANEL ASSY

ASSEMBLY NO.
1101-00-0071

PAGE: 1

REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
19	NYLON FLAT WASHER	2264-N-385	AMTOM	2600-20-0005	3
3	PUT,SWITCH MOU [illegible]	4009-00-0006	WVTK	4009-00-0006	1
11	SWITCH ASSY SLIDE	40256-LF	SMCFT	5105-00-0002	1
7	SOLDER GUARD	40256-LF-SG	SMCFT	5105-04-0001	1

WAVETEK PARTS LIST

TITLE
REAR PANEL ASSY

ASSEMBLY NO.
1101-00-0071

PAGE: 2

REV G

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE
MATERIAL	PROJ ENGR	
	RELEASE APPROV	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 ANGLES ± .XX ± .030	
	DO NOT SCALE DWG	

WAVETEK SAN DIEGO • CALIFORNIA

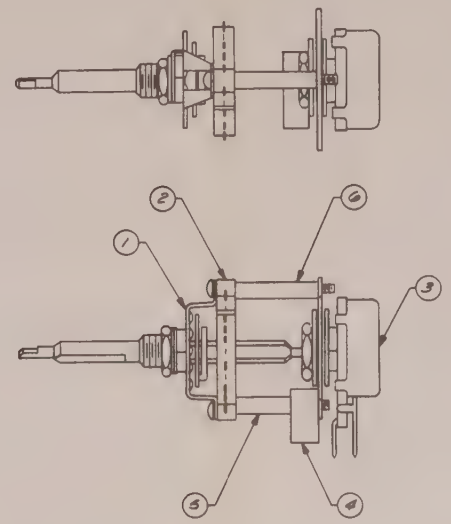
TITLE
REAR PANEL ASSY

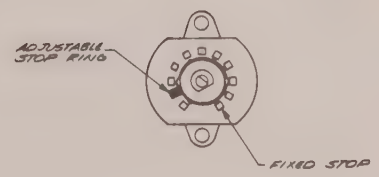
SIZE A | DWG NO 1116-0114 1101-00-0071 | REV G

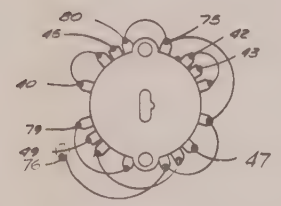
SCALE 46 | 23338 | SHEET 1

NOTE UNLESS OTHERWISE SPECIFIED

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED







2. SWITCH SHOWN IN FULL CCW POSITION
1. SWITCH VIEWED FROM KNOB END OF BOARD
NOTES:

REV	ECN	BY	DATE	APP
C	1957	BR	5-11-79	
B	945	BA	6-20-74	
A	ECN 462	B.	9/6/71	

TOLERANCE UNLESS OTHERWISE SPEC
.XXX ± .010
.XX ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE –

BY GRAY DATE 3-29-72 APP

MATERIAL –

TITLE SWITCH ASSY TRIGGER 2 of 2

FINISH –

MODEL NO. 116 DWG NO. 202-00-0015 REV 1

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REV	ECN	BY	DATE	APP

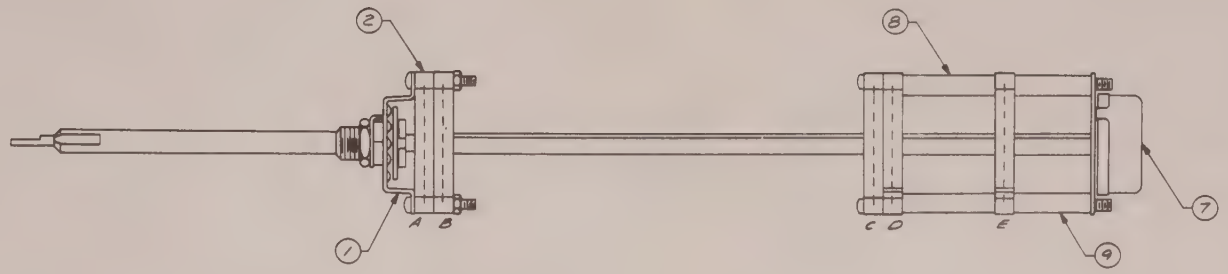
REFERENCE DESIGNATIONS	PART DESCRIPTION	MANUFACTURER'S PART NO.	MFR	WAVETEK NO.	QTY
4	BLOCK,SUPPORT	[illegible]	[illegible]	1400-00-1263	.
5	SPACER	[illegible]	[illegible]	1400-00-4123	
6	SPACER,1/8"	1400-00-6813	AVTK	1400-00-6813	1
3	POT,CONT,10K FROM:4000-01-8507	4609-71-0313	AVTK	4609-71-0313	1
2	WAFER	T-104	CTS	5100-02-0003	.
1	DETENT,MOD FROM:5100-01-4001	5100-99-0002	AVTK	5100-99-0002	1

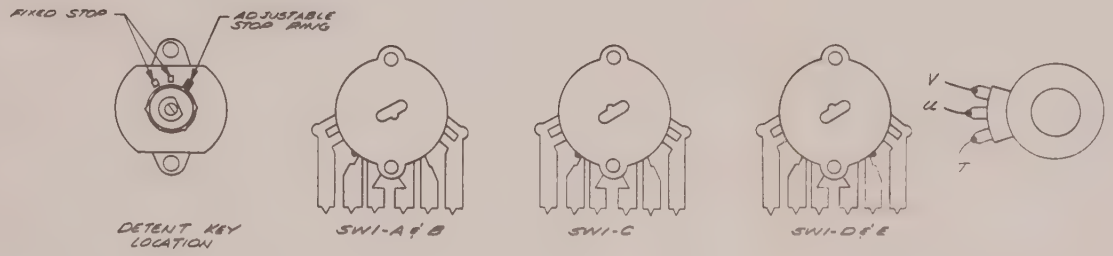
WAVETEK PARTS LIST	TITLE TRIG SW ASSY	ASSEMBLY NO 1202-00-0015 PAGE 1	REV

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE TRIGGER SWITCH
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1		
	DO NOT SCALE DWG	MODEL NO 146	DWG NO 1202-00-0015 REV C
	SCALE	CODE IDENT 23338	SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED





2. SWITCH SHOWN IN FULL CCW POSITION
1. SWITCH VIEWED FROM KNOB END OF BOARD
NOTES:

B	945	BA	6-30-76
A	884		9-12-74

TOLERANCE UNLESS OTHERWISE SPEC	REV	DSN	BY	DATE	APP
.XXX ± .010 .XX ± .030 ANGLES ± 0°30'					

WAVETEK SAN DIEGO, CALIFORNIA

SCALE –

BY GRAY DATE 9-12-74 APP

MATERIAL –

TITLE SWITCH ASSY FREQ Hz

FINISH –

MODEL NO 146 DWG NO 1702-00-0016 REV B

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	UNIQ-MFSW-PART-NO	MFGR	WAVETEK NO.	QTY/PT
0	SPACER	142-100	WVTK	1800-00-2073	2
9	SPACER,3/8"	1400-00-0013	WVTK	1800-00-0013	2
7	FUI,LUNT,10A	150-A1A	WVTK	4600-01-0305	1
2	WAFER	142-001-1	WVTK	5104-02-0013	5
NONE	SWITCH STUP	CIC-33-000	CTS	5104-07-0002	1
1	DETENT MOD FROM:5104-01-0010	5104-99-0003	WVTK	5104-99-0003	1

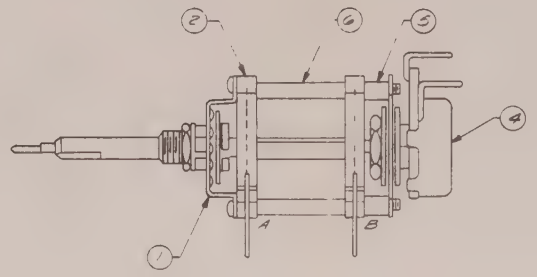
WAVETEK PARTS LIST

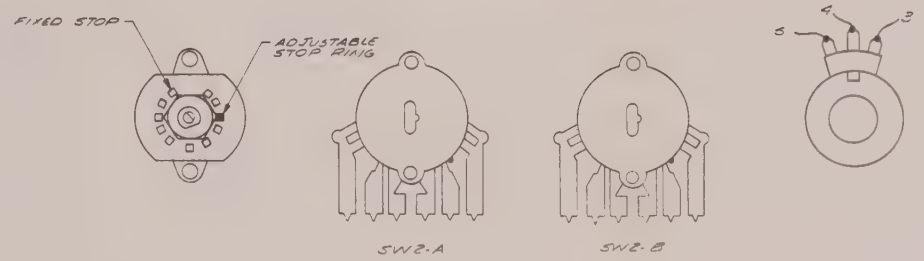
TITLE	ASSEMBLY NO.	REV
FREQ SW ASSY	1202-00-0016	0
	PAGE: 1	

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE FREQ SW
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ± XX ±.030		
	DO NOT SCALE DWG		MODEL NO 96 / DWG NO 1202-00-0016 / REV E
	SCALE		STOCK NO. 23338 / SHEET 1 OF

NOTE UNLESS OTHERWISE SPECIFIED

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED





2. SWITCH SHOWN IN FULL CCW POSITION
1. SWITCH VIEWED FROM KNOB END OF BOARD
NOTES:

TOLERANCE UNLESS OTHERWISE SPEC					
.XXX	±.010	REV	ECN	BY	DATE	APP
.XX	±.030					
ANGLES	±0°30'					

WAVETEK
SAN DIEGO CALIFORNIA

SCALE —	BY GRAY	DATE 9-26-78	APP.
MATERIAL —	TITLE SWITCH ASSY ATTENUATOR		
FINISH —	MODEL NO. 186	DWG NO. 003-00-001	REV A

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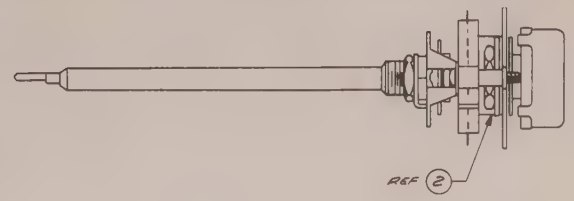
REV	ECN	BY	DATE	APP

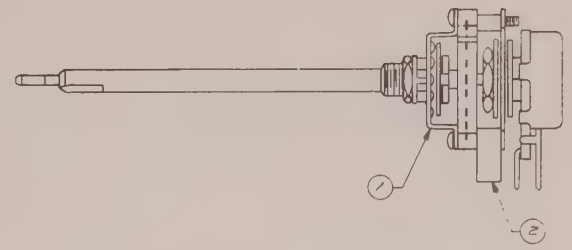
REFERENCE DESIGNATIONS	PART DESCRIPTION	OWING-MODUM-PART-NO	MFGR	WAVETEK NO.	QTY/PRI
8	SPACER,3/4"	1400-00-0013	MVTK	.1400-00-0013	2
5	SPACER	0501	SMJIN	2800-00-0005	2
4	POT,LONT,10K	130-K10	MVTK	1400-01-0307	1
1	DETENT	130-000	MVTK	1510-01-0043	1
2	WASHER	142-3A1-1	MVTK	1510-02-0013	2
NONE	SWITCH ATTN	212-33-006	CTS	1510-07-0002	1

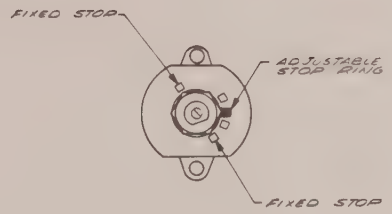
WAVETEK PARTS LIST	TITLE ATTEN SW ASSY	ASSEMBLY NO. 1202-00-0017 PAGE: 1	REV A

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJECTION		TITLE ATTEN SW
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG	MODEL NO 146	DWG NO 1202-00-0017 REV A
	SCALE	CODE IDENT 23338	SHEET OF

NOTE UNLESS OTHERWISE SPECIFIED







SW2

NOTES:

2. SWITCH SHOWN IN FULL CCW POSITION
1. SWITCH VIEWED FROM KNOB END OF BOARD

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

REV	ECN	BY	DATE	APP
B	945	B.	2-20-74	
A	ECN 73	B.	9/16/72	

TOLERANCE UNLESS OTHERWISE SPEC
.XXX ± .010
.XX ± .030
ANGLES ± 0°30'

WAVETEK
SAN DIEGO CALIFORNIA

SCALE —
BY GRAY DATE 3-27-72 APP

MATERIAL —

FINISH —

TITLE
SWITCH ASSY
D.C. OFFSET

MODEL NO. 146
DWG NO. 00200-006
REV E

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REV	ECN	BY	DATE	APP

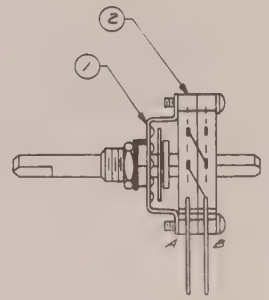
REFERENCE DESIGNATIONS	PART DESCRIPTION	MANUFACTURER PART NO	MFGR	WAVETEK NO.	QTY/PC
E	BLOCK,COMPONT	130-328	WETA	1409-00-1265	1
1	SWITCH ASSY MOTAMT	130-406	WETA	3100-00-2011	1
NONE	SWITCH STOP	612-33-006	CTS	3100-27-0002	1

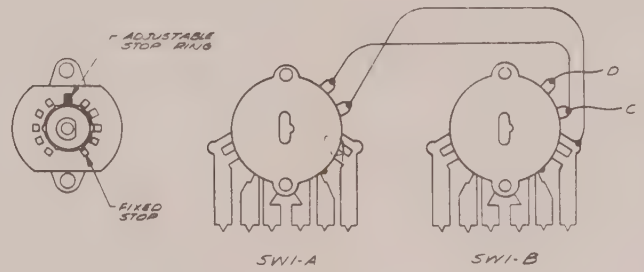
WAVETEK PARTS LIST	TITLE D/C OFFSET SW ASSY	ASSEMBLY NO. 1202-00-0018 PAGE: 1	REV 0

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	CHECKED		TITLE D/C OFFSET SW
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ±1 .XX ± .030		
	DO NOT SCALE DWG	MODEL NO 140	DWG NO 202-00-0018 REV B
	SCALE	CODE IDENT 23338	SHEET OF

NOTE UNLESS OTHERWISE SPECIFIED

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED





2. SWITCH SHOWN IN FULL CCW POSITION
1 SWITCH VIEWED FROM KNOB END OF BOARD

NOTES:

TOLERANCES UNLESS OTHERWISE SPEC: .XXX ± .010, .XX ± .005, ANGLES ± 0°30'	REV	ECN	BY	DATE	APP
SCALE –	WAVETEK SAN DIEGO CALIFORNIA				
	BY GRAY	DATE 9-29-72	APP		
MATERIAL –	TITLE SWITCH ASSY FREQ/PERIOD				
FINISH –	MODEL NO 186	DWG NO 12800-009	REV B		

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REV.		BY	DATE	APP.

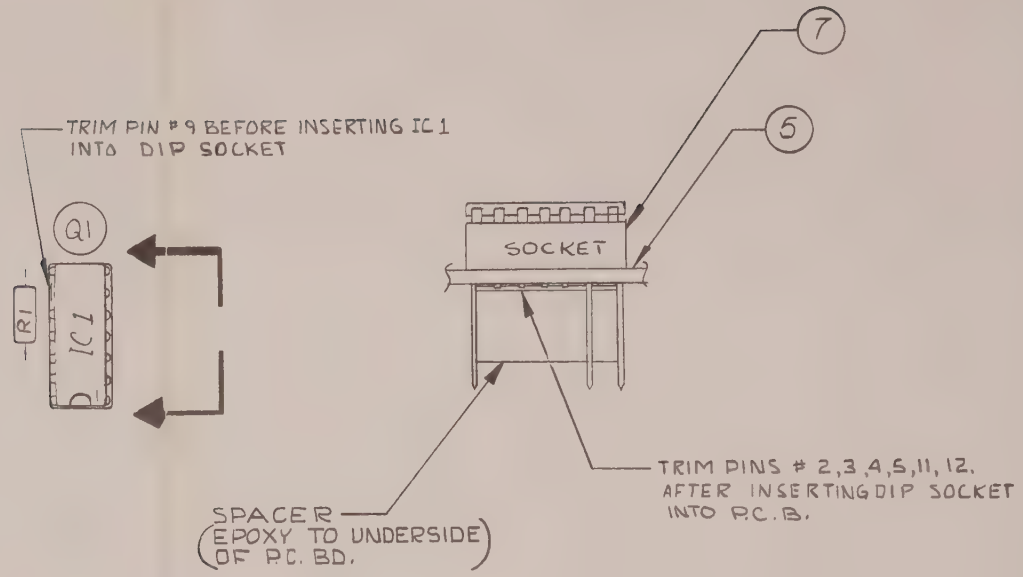
REFERENCE DESIGNATORS	PART DESCRIPTION	UNIQ-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
2	WAFER	133-5MI-1	MVIK	5104-02-0008	2
NONE	SWITCH STOP	212-33-006	CTS	5104-07-0002	1
1	DETENT,MOD PROMISING-01-0003	5104-99-0002	MVIK	5104-99-0002	1

WAVETEK PARTS LIST	TITLE FREQ/PERIOD SW ASSY	ASSEMBLY NO 1202-00-0019 PAGE 1	REV H

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE FREQ/PERIOD SW
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 ANGLES ± .XX ± .030		
	DO NOT SCALE DWG	MODEL NO 146	DWG NO 1202-00-0019 REV 3
	SCALE	CAGE CODE 23338	SHEET OF

A	ECN 1472	120	9-28-76



WAVETEK
PATCH BLOCK (MODEL 154)
1205-00-0489 A
B 3-11-76 K.Lo
SHT. 2 of 2

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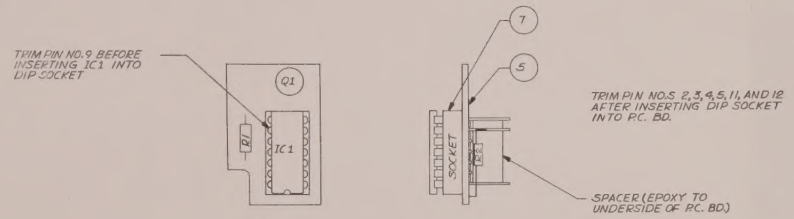
REV	ECN	BY	DATE	APP
A	ECN NO. 1472	RO	9-28-76	
B	REDRAWN (NO CHANGES)	DC	12-5-79	
C	# 1999	[illegible]	7-17-79	[illegible]



REFERENCE DESIGNATIONS	PART DESCRIPTION	UNIQ-MFGN-PART-NO	MFGN	MFGR'S PART NO.	QTY/PT
3	SPACER	1405-00-0601	[illegible]	1430-00-0601	1
5	CHIP REPLACEMENT NO	158-120	[illegible]	1700-05-0049	1
7	SKT,IC,16PIN,AX	C542000-1696	SAE	2100-01-0002	1
R2	RES,MF,1/4W,1%,3.01K	R0550-4011P	TRW	4701-01-3011	1
R1	RES,MF,1/4W,1%,4.99K	R0550-4991P	TRW	4701-01-4991	1
Q1	TRANS	2N4302	[illegible]	4301-01-4600	1
IC1	IC	74LS74	TI	5000-74-7410	1

WAVETEK PARTS LIST	TITLE PATCH BLOCK	ASSEMBLY NO. 1205-00-0049 PAGE: 1	REV C

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN D. COOPER	DATE 12-5-79	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PATCH BLOCK
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1° XX ±.030		
	DO NOT SCALE DWG		MODEL NO 144, 146, 154 / DWG NO. 1205-00-0489 / REV C
	SCALE		CODE IDENT 23338 / SHEET 2 OF 2

NOTE: UNLESS OTHERWISE SPECIFIED

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